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AUTHOR Quinn, Bill; Foshay, Rob; Morris, Barbara
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ABSTRACT

The "PLATO[R] Math Expeditions" and "PLATO[R] Projects for the Real World" curricula are designed to implement effective, research-based instructional practices. "Math Expeditions" is designed to give elementary grade users the mathematics skills and practice needed to solve real-life problems. Across the eight Levels, A through I (K-8), this curriculum provides opportunities in 134 lessons and 399 activities for students to learn number facts and operations, fractions, measurement, geometry, ratios/proportions, probability/statistics, and reasoning skills. This curriculum can be used alone or in conjunction with "Projects for the Real World," which include activities such as map reading and labeling, graphs, photos of Maya ruins and planets, planning, and writing. In Levels A through I, 46 units include 245 projects with a total of 793 activities, all with a great variety of learner activity. Learners solve math problems, and are asked to integrate the math with the full range of activities in each project. In one project, a learner can be asked to tabulate and display data, do addition in order to answer questions, draw graphs, and play learning games. Together, "Math Expeditions" and "Projects for the Real World" offer over 830 hours of instruction and practice in mathematics skills and strategies. These courses can be combined with the other highly successful PLATO courses, particularly Math Fundamentals, Pre-Algebra. Following a review of research that discusses instructional issues in six specific areas of instructional focus, this Technical Paper consists of five parts focusing on: research on early mathematics instruction; the need for new curriculum in early mathematics; the PLATO[R] early math curricula; PLATO[R] Learning's "Math Expeditions" program (including a table that lists projects and activities for specific skills taught in each grade level); "Projects for the Real World" (including a table that lists units, skill, and number of activities in which topics are used for levels A through I); and teaching with PLATO[R] early mathematics. (Contains 40 references.) (AEF)

PLATO®

Teaching Early Mathematics with PLATO® Software

An Overview of the New PLATO Elementary Mathematics Curricula and How to Use Them

Technical Paper #11

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Bill Quinn, Ed.D.
Quinn Consulting

Rob Foshay, Ph.D.
PLATO Learning, Inc.

Barbara Morris
PLATO Learning, Inc.

PLATO Learning, Inc.
10801 Nesbitt Avenue South
Bloomington, MN 55437
(800) 869-2000
http://www.plato.com

author s e-mail:
rfoshay@plato.com

Abstract

Research on effective mathematics instruction has helped to define what instructional methods and content are most valuable. Recent reports summarizing this research have focused educators and others across the country on what works best in teaching children mathematics. The research has shown that the following are important aspects of mathematics instruction:

- Skill Modeling and Practice with Feedback
- Collaborative Learning
- Computation, Mental Math and Estimation
- Problem-Solving
- Active Learning with Real-World Connections
- Curriculum and Mathematics Integration

Math capability has been the subject of public concern for decades. Far too many children are not proficient in mathematics and are therefore precluded from learning what they might, both in and outside of school. Particularly affected are at-risk learners in urban and rural schools who have relatively fewer home and community supports. Effectively addressing this situation holds out great promise for the social and economic future of America.

Improved mathematics curricula and teaching methods are needed if the mathematics abilities of America s children are to increase. Research results have yielded insight into how to change mathematics instruction. The *PLATO® Math Expeditions* and *PLATO® Projects for the Real World* curricula are designed to implement effective, research-based instructional practices.

Math Expeditions is designed to give elementary grade users the mathematics skills and practice needed to solve real-life problems. Across the eight levels A to I, this curriculum provides numerous opportunities in 134 lessons and 399 activities for learners to learn number facts and operations, fractions, measurement, geometry, ratios/proportions, probability/statistics, and reasoning skills in their quest to become proficient math thinkers. This curriculum can be used alone or in conjunction with *Projects for the Real World*.

Projects for the Real World include activities such as map reading and labeling, graphs, photos of Maya ruins and planets, planning, and writing. That s not only integration across the disciplines; it s interesting and fun. In Levels A through I (grades K-8), 46 units include 245 projects with a total of 793 activities, all with a great variety of learner activity. Not only do learners solve math problems, but they are asked to integrate the math with the full range of activities in each project. In one project a learner can be asked to tabulate and display data, do addition in order to answer questions, draw graphs, and play learning games.

Together, *Math Expeditions* and *Projects for the Real World* offers over 830 hours of instruction and practice in mathematics skills and strategies. These courses can be combined with the other highly successful PLATO courses, particularly Math Fundamentals, Pre-Algebra and Algebra, to present a full range of resources to move learners from beginning to proficiency in mathematics.

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Part
1

Research on Early Mathematics Instruction

This review of mathematics research focuses on the instructional practices that have been demonstrated as being effective for learning mathematics. A key finding from this research is that there is no one best way to teach a particular math skill or capacity. A variety of instructional methods and teaching approaches have been shown to be effective, depending upon the instructional objective and learner characteristics. An effective math program will likely involve a mix of instructional approaches, including direct instruction on well-structured tasks and problem-solving activities utilizing more open assignments and methods. Individual interests and learning needs should be recognized in the math instruction.

Even though a range of methods have proven successful in teaching early mathematics, across these methods the following areas of instructional focus have proven especially effective in helping young learners to learn mathematics:

- Skill Modeling and Practice with Feedback
- Collaborative Learning
- Computation, Mental Math and Estimation
- Problem-Solving
- Active Learning with Real-World Connections
- Curriculum and Mathematics Connections

This review of research discusses some of the instructional issues regarding these areas of instruction.

Skill Modeling and Practice with Feedback

The most often used measures of learner achievement in the U.S. are scores on standardized tests of basic skills. Using this criteria as the desired learner outcome, one set of models, labeled direct or explicit instruction (Rosenshine, 1995), has developed overwhelming research support in the past 25 years. Several principles of direct instruction, such as more teacher direction and learner-teacher interaction, provide the foundation for this approach. These methods of direct instruction or focused instruction have been used to teach mathematics and other subjects to a wide range of learners regardless of ethnicity, family background, or socioeconomic status. For example, both large scale and smaller scale experimental research comparing the outcomes of different forms of instruction show that:

1. Children who are taught math using direct instruction methods--such as *Connecting Math Concepts* (Engelmann & Carnine, 1992)--generally outperform (both academically and with respect to self-esteem) children taught with other forms of instruction. (Adams & Engelmann, 1996; Becker & Carnine, 1981; Bock, Stebbins, & Proper, 1977; Tarver & Jung, 1995; Watkins, 1997).

2. The early gains of children who were taught some subjects with direct instruction are sustained in later grades. For example, Meyer (1984) followed children (predominantly Black or Hispanic) in the Ocean Hill-Brownsville section of Brooklyn who had been taught reading and math using direct instruction methods in elementary school. At the end of the 9th grade, these learners were still one year ahead of children who had been in control schools in reading, and 7 months ahead of control

children in math. Similar results were found by Gersten, Keating and Becker (1988). Former direct instruction learners continued to out-perform children who had received traditional instruction. In addition, in contrast to comparison groups of children who had not received direct instruction in earlier years, former direct instruction learners had higher rates of graduating high school on time, lower rates of dropping out, and higher rates of applying and being accepted into college (Darch, Gersten, & Taylor, 1987; Meyer, Gersten, & Gutkin, 1983).

Caldwell, Huitt, and French (1995) provide a direct instruction analysis from a transactional perspective. From this viewpoint, both the teacher and learner are active participants in the learning process, each with their respective responsibilities. At each event of instruction, the transactional perspective provides both a recommended teacher activity and a set of alternative learner activities. The most important deviation from the other models is that the transactional perspective emphasizes teacher/learner interaction at every event in the lesson.

The following chart (adapted from Slavin, 1994, p. 287) provides a comparison of instructional events from several well-known direct instruction models that incorporate these principles.

Good & Grouws (1979) (Missouri Mathematics Program)	Slavin (1994)	Gagne (1977); Gagne & Briggs (1979)[1]	Rosenshine (1995)	Hunter (1982) (Mastery Teaching)
1. Opening	1. State learning objective and orient learners to lesson	1. Gain and control attention; inform the learner of expected outcomes	1. Provide overview	1. Objectives; provide anticipatory set.
2. Review homework; mental computations; review prerequisites	2. Review prerequisites	2. Stimulate recall of relevant prerequisite capabilities	2. Review, checking previous day's work	2. Review
3. Development	3. Present new material	3. Present the stimuli inherent to the learning task; offer guidance for learning	3. Present new content & skills	3. Input & modeling
4. Assess learner comprehension	4. Conduct learning probes	4. Provide feedback	4. Initial learner practice, checking for understanding, feedback & correctives	4. Check understanding and guided practice
5. Seatwork	5. Provide independent practice		5. Independent practice	5. Independent practice
	6. Assess performance and provide feedback	5. Appraise performance	6. Frequent tests	
6. Homework; weekly and monthly reviews	7. Provide distributed practice and review	6. Make provisions for transferability; ensure retention	7. Homework; weekly and monthly reviews	6. Homework

Collaborative Learning

Effective communication and collaboration are essential to becoming a successful learner. It is primarily through dialogue and examining different perspectives that learners become knowledgeable, strategic, self-determined, and empathetic. Moreover, involving learners in real-world tasks and linking new information to prior knowledge requires effective communication and collaboration among teachers, learners, and others. Indeed, it is through dialogue and interaction that curriculum objectives come alive. Collaborative learning affords learners enormous advantages not available from more traditional instruction because a group--whether it be the whole class or a learning group within the class--can accomplish meaningful learning and solve problems better than any individual can alone. (Tinzmann, et. al., 1990)

[1] As discussed below, the PLATO tutorial strategy is an extension of the Gagne/Briggs model, but with independent practice added, and with a number of other enhancements based on current instructional theory.

Cook (1993) noted that placing learners in small groups of two to six learners is an excellent instructional strategy for promoting reflective thought and for maximizing learner involvement in mathematics interaction. A number of researchers in recent years have demonstrated the high degree of learning possible when learners can collaborate in learning tasks and when they use their own knowledge as a foundation for school learning (Moll, 1989; Moll and Diaz, 1986; Palincsar and Brown, 1989; Palinscar, Ramson, and Derber, 1988/89; Brown, Palincsar, and Purcell, 1986).

Collaborative classrooms seem to have four general characteristics. The first two capture changing relationships between teachers and learners. The third characterizes teachers' new approaches to instruction. The fourth addresses the composition of a collaborative classroom.

1. *Shared knowledge among teachers and learners*. The teacher has vital knowledge about content, skills, and instruction, and still provides that information to learners. However, collaborative teachers also value and build upon the knowledge, personal experiences, language, strategies, and culture that learners bring to the learning situation.

2. *Shared authority among teachers and learners*. In collaborative classrooms, teachers share authority with learners in very specific ways. Collaborative teachers invite learners to set specific goals within the framework of what is being taught, provide options for activities and assignments that capture different learner interests and goals, and encourage learners to assess what they learn. Collaborative teachers encourage learners' use of their own knowledge, ensure that learners share their knowledge and their learning strategies, treat each other respectfully, and focus on high levels of understanding. They help learners listen to diverse opinions, support knowledge claims with evidence, engage in critical and creative thinking, and participate in open and meaningful dialogue.

3. *Teachers as mediators*. As knowledge and authority are shared among teachers and learners, the role of the teacher increasingly emphasizes mediated learning. Successful mediation helps learners connect new information to their experiences and to learning in other areas, helps learners figure out what to do when they are stumped, and helps them learn how to learn. Above all, the teacher as mediator adjusts the level of information and support so as to maximize the ability to take responsibility for learning.

4. *Heterogeneous groupings of learners*. The perspectives, experiences, and backgrounds of all learners are important for enriching learning in the classroom. As learning beyond the classroom increasingly requires understanding diverse perspectives, it is essential to provide learners opportunities to do this in multiple contexts in schools. In collaborative classrooms where learners are engaged in a thinking curriculum, everyone learns from everyone else, and no learner is deprived of this opportunity for making contributions and appreciating the contributions of others. Thus, a critical characteristic of collaborative classrooms is that learners are not segregated according to supposed ability, achievement, interests, or any other characteristic.

Computation, Mental Math and Estimation

Computation, mental math and estimation are closely related topics. Reyes and Reyes (1990) provide a clear discussion of their inter-relationship.

> *Do you estimate? Of course you do. Everyone estimates. Research shows that estimation is used in real-world problem solving far more than exact computation. Furthermore, estimation relates to every important mathematics concept and skill developed in elementary school. It is a process that allows the user to form an estimate or to judge the reasonableness of a result. The NCTM's Curriculum and Evaluation*

Standards for School Mathematics (Standards, 1989) discusses both measurement estimation, for example,

About how high can you count in one minute?

About how many beans are in a 1kg bag (fig. 1)?

Is more than 1/2 the area shaded?

and computational estimation, for example,

Have you lived 10,000 days?

I multiplied 48 by 0.27 on my calculator and got 129.6. Can that be right?

Everything is reduced 35 percent. About how much is saved on the stereo in figure 2?

These questions and the discussion of solutions offer many opportunities for developing number sense.

Estimation includes various interrelated concepts and skills, including mental computation, concept development and number sense. In fact, research suggests that number sense, mental computation, and estimation are often very difficult to separate. Further, the development of any one of these abilities often stimulates further growth in the others.

In the Standards, estimation is highlighted not as an end in itself but as a means for helping students "develop insights into concepts and procedures, flexibility in working with numbers and measurements, and an awareness of reasonable results" (p. 36). The study of estimation should be integrated with the study of concepts underlying whole numbers, fractions, decimals, and rational numbers so that these concepts can be constructed meaningfully by the learner. The exploration of a wide range of student-generated estimation strategies is recommended. The use of rounding to estimate is singled out for less attention in the Standards. Research and common sense clearly document that traditional rounding rules (rounding to the nearest ten, hundred, thousand, etc.) are often inappropriate and inefficient when estimating. Rather than follow rigid rules for estimating, students should be encouraged to use their knowledge about number to form estimates that are reasonable in the context of the problem. Often this strategy may call for "rounding" to numbers that are more compatible with the computation involved.

In grades K-4, the curriculum should include estimation so that students can-

explore estimation strategies;

recognize when an estimate is appropriate:

determine the reasonableness of results;

apply estimation in working with quantities, measurement, computation, and problem solving. (Reys and Reys, 1990)

Even though these topics work so well together in a curricular sense, for the learner they are not at all the same in the way in which they are processed and remembered. Recent brain research has demonstrated that learning math facts is very different from applying mathematical reasoning. A recent MIT news release (Halbert, 1999), based on work reported in Science Magazine by French and MIT researchers, reported that learning the multiplication table may be more akin to memorizing a laundry list than exercising mathematical skills. Meanwhile, learning to approximate how numbers relate to each other seems to be tied to intuition about space.

Through separate studies involving behavioral experiments and brain-imaging techniques, the researchers found that a distinctly different part of the brain is used to come up with an exact sum, such as 54 plus 78, than to estimate which of two numbers is closer to the right answer; exact arithmetic uses a part of the brain usually active during verbal memory tasks This part of the brain, while not a primary language area, is activated when subjects have to remember verbal material.

Further, approximating seems to require a more spatial tool, such as a mental number line. This spatial tool, which some call number sense, may be the most important source of mathematical intuition, although this intuition probably also results from interplay between the two brain systems involved. The brain-imaging evidence shows that approximate calculations take place in the brain's large-scale network involved in visual, spatial and analogical mental transformations...For years, mathematicians, including Einstein, have said that they rely more on mental signs and images than words.

Halbert wrote that not only were these math activities conducted in different locations, but also the two kinds of math problems were instantaneously assigned by the brain to their respective areas, suggesting that the calculation itself, not just the decision to perform it, is completed by specific circuits depending on whether an exact or approximate result is required.

Problem-Solving

The NCTM standards (1989) have been well received by national educational groups, the U.S. Department of Education, and the states as they reviewed or formulated new state standards, new benchmark tests, and new curriculum materials. The NCTM standards have led to less emphasis on skills for their own sake, more on deep understanding of important concepts that spiral through curricula and are interrelated.

The standards suggest addressing richer, multi-step mathematics problems. One way this can be applied is to have instruction begins with a real world example rather than teaching concepts in the abstract. For example, graphing an equation is taught to show how real situations can be described by graphing data or graphing the equation that describes the data. Standards-based approaches to teaching mathematics build in more questions requiring explaining the processes and thinking behind the solution, or solutions. Math problem solving is designed to provide more modeling, investigating, explaining, and showing multiple solutions

A recent study shows the benefit of approaching mathematics problem solving with a conceptual emphasis. A study of high and low achieving US classes (Nowell, Masini, and

Quinn) found that teacher instructional practices produced measurable effects on learner TIMMS math achievement. In Grade 8 classes, teaching practices are related to higher or lower math achievement. Specifically, drilling learners on procedures and application of rules is associated with lower-achieving classes and focusing on understanding and explaining concepts is associated with higher-achieving classes. More teachers in higher-achieving classes ask learners to explain the reasoning behind an idea and write equations to represent relationships. While these results do not directly test the Standards for teaching developed by NCTM, they do show that teaching in a way compatible with the Standards is associated with higher math achievement.

Active Learning with Real-World Connections

Learning does not mean simply receiving and remembering a transmitted message; instead, "educational research offers compelling evidence that learners learn mathematics well only when they construct their own mathematical understanding" (Mathematical Sciences Education Board, 1990, p. 58). When educators begin to see learning as knowledge construction, they change their thinking about curriculum, instruction, and assessment, developing more powerful approaches to connecting thinking and mathematics and designing more mathematically significant instructional learning experiences (Cook, 1995).

Burns (1992) noted that not only is it important to consider the content of the mathematics curriculum, it's important to consider how learners learn mathematics. Learners need to learn mathematical concepts and to see relationships among these concepts. Because mathematics concepts are understood only as they relate to the overall framework of understanding held by each learner, children must construct these connections through an active process. Such learning experiences are:

- *Hands-on*, involving learners in really doing mathematics - experimenting first-hand with physical objects in the environment (manipulatives) and having concrete experience before learning abstract mathematical concepts
- *Minds-on*, focusing on the core concepts and critical thinking processes needed for learners to create and re-create mathematical concepts and relationships in their own minds
- *Authentic*, allowing learners to explore, discover, discuss, and meaningfully construct mathematical concepts and relationships in contexts that involve real-world problems and projects that are relevant and interesting to the learner.

Curriculum and Mathematics Integration

Research has verified the importance of building on learners' prior knowledge when helping them learn new concepts. This approach verifies not only the importance of articulating learners' math experiences from kindergarten through grade 12 but also the importance of aligning learners' math experiences with their other experiences both inside and outside school. Educators should keep in mind that the development of a child involves multiple settings--the home, the neighborhood, the school, and the workplace. People learn and grow in all of these settings. Learners of all ages construct meaning about themselves and their world out of personal experiences, including the influences of culture (Caine and Caine, 1991; Beane, 1995). Learning is enhanced when curriculum and instruction integrate learner experiences with the development of meaning. Iran-Nejad, McKeachie, and Berliner (1990) state, "The more meaningful, the more deeply or elaborately processed, the more situated in context, and the more rooted in cultural, background, cognitive, and personal knowledge an event is, the more readily it is understood, learned, and remembered" (p. 511).

The National Council on the Teaching of Mathematics (NCTM, 2000), in its landmark *Principles and Standards for School Mathematics*, gives the following pointers on the need for an articulate, coherent, and integrated math curriculum:

- A well-articulated curriculum challenges learners to leam increasingly more sophisticated mathematical ideas as they continue their studies.
- A mathematics curriculum should be well articulated across the grades.
- A mathematics curriculum should be coherent. Mathematics comprises different topical strands, such as algebra and geometry, but the strands are highly interconnected [and] displayed prominently in the curriculum and in instructional materials and lessons Learners can see how the ideas built on, or connect with, other ideas, thus enabling them to develop new understandings and skills. An effective mathematics curriculum focuses on important mathematics mathematics that will prepare learners for continued study and for solving problems in a variety of school, home, and work settings.

Note that *both* skills and applications such as problem solving are mentioned in this list. If learners are to become facile with mathematics, they need automaticity with skills and facility with mathematical reasoning.

The phrase integration of mathematics instruction may refer to either of two mathematics: (1) mathematics joined with other school subjects, such as math and social studies, and (2) different types of mathematics joined with each other, such as algebra and geometry. Both of these curricular combinations are legitimate ways of intertwining math so that it is better understood and appreciated.

The January 2001 Dialogues , the NCTM Web site forum for essays, presented two such writings on the topic of mathematics integration. Donna Berlin (2001) gave a discussion of an international view of integration noting that the topic of an inter-related mathematics curriculum was begun at the tum of the last century, around 1900. As such, it included two major components of middle school philosophy interdisciplinary teaching and coherent learning. A three-part vision emerged Interrelatedness of mathematical topics mathematics connected with other subjects in the curriculum and mathematics connected with students interests.

Burkhardt (2001) stated the following:

> The main advantages of integrated curricula are that they build essential connections, help make mathematics more usable, avoid long gaps in learning, allow a balanced curriculum, and support equity. I know of no comparable disadvantages, provided that the "chunks" of learning are substantial and coherent.

> Building a student's robust cognitive structure, one that can be used flexibly and effectively in solving problems, depends on linking new concepts and skills with the student's existing understanding. This happens through active processing over an extended period, first of weeks as the curriculum points out key links, ultimately over years as the concepts are used in solving problems across a variety of contexts.

> Compartmentalizing mathematics inhibits building such connections. For example, the different functions that represent the scaling of lengths, areas, and volumes are a practical example of links between algebra and geometry and the real world. The

profound fact that doubling all lengths multiplies all areas by 4 and volumes by 8 underlies home-heating calculations and accounts for upper limits on the size of insects.

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Part
2

The Need

Learner Math Performance in Early Grades

The need for higher elementary and middle school mathematics achievement is widely recognized in the popular press and the professional literature. About one-third of elementary and middle school children are judged to be below acceptable levels in mathematics. Here is one of many studies to illustrate this need. In a national test of fourth-grade and eighth-grade learners in 2000[2], about one-third (31% for 4th Grade, 34% for 8th Grade) demonstrated math performance below a minimally acceptable level. This problem was particularly acute for learners who come from economically disadvantaged backgrounds and from very urban settings. Lower scores were achieved by Black learners (68% below basic), Hispanic learners (59%), and American Indian learners (58%). In this study, learner math performance was reported at one of four achievement levels —

- *Below Basic:* Less than adequate mastery of mathematics for fourth grade work.
- *Basic:* Partial mastery of knowledge and skills for proficient work at fourth grade
- *Proficient:* Solid academic performance in mathematics.
- *Advanced:* Superior performance in mathematics.

Test scores like these help explain why the nation s concern about the mathematics achievement of its youth is at a high level.[3] It is clear that achievement in mathematics in an increasingly technological society will have a major impact on students' "career aspirations, their role in society, and even their sense of personal fulfillment."[4] We have come to realize the impact that early mathematics learning could have on the life our youth. In the past mathematics has received little attention in many early elementary classrooms.[5] This situation is changing as mathematics achievement is recognized as critical to school success.

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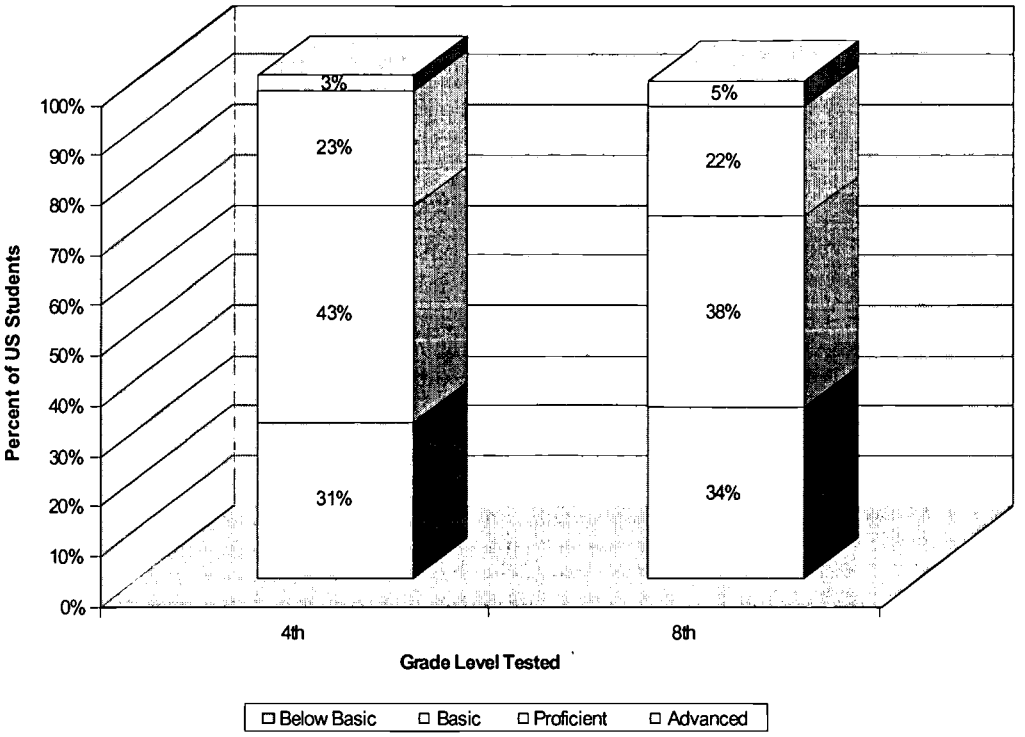
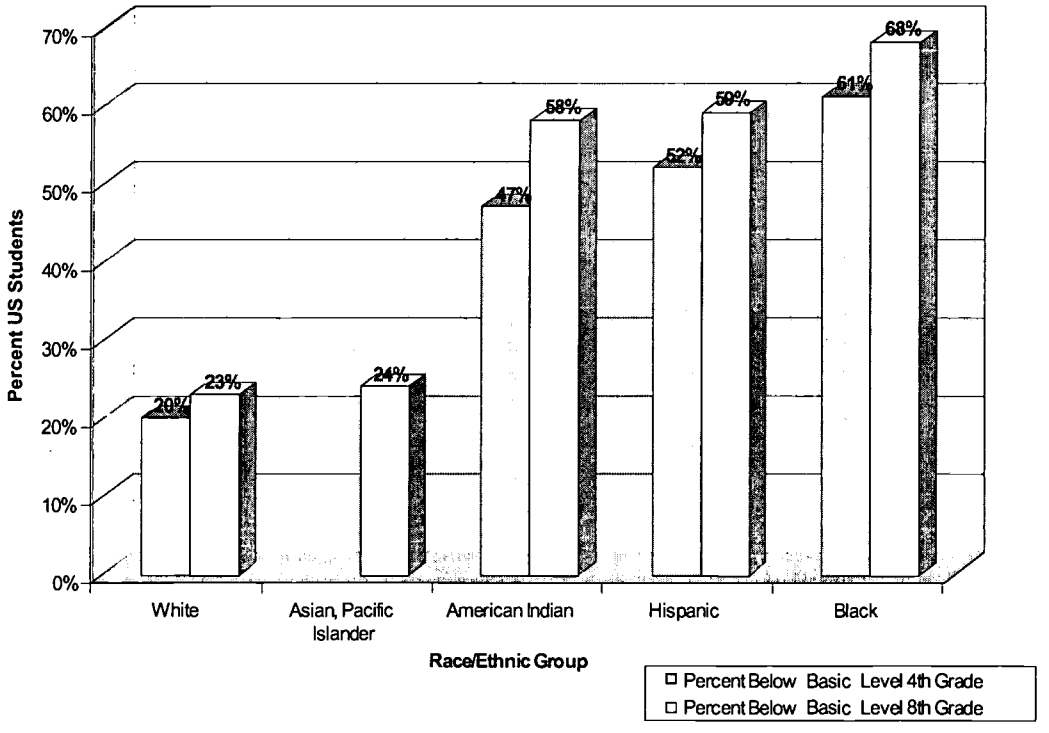
[2] Data Source: Braswell J.S., Lutkus A.D., Grigg W.S., Santapau S.L., Tay-Lim B., and Johnson M. (August, 2001). *The Nation s Report Card: Mathematics 2000.* Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, National Center for Education Statistics. NCES 2001-517.

[3] Richardson, K. (2000). *Mathematics Standards for Pre-Kindergarten through Grade 2.* ERIC Digest. Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. ED446826.

[4] Malcom, S. (1999). *Making sense of the world.* In American Association for the Advancement of Science, Dialogue on early childhood Science, mathematics, and technology education. Washington, DC: AAAS. ED 427 877.

[5] Johnson, J. R. (1999). The forum on early childhood science, mathematics, and technology education. In American Association for the Advancement of Science, Dialogue on early childhood Science, mathematics, and technology education. Washington, DC: AAAS. ED 427 877.





The current interest in mathematics education can be traced to the 1980s and the national reports that focused attention on an impending crisis in education, particularly in mathematics and science: *An Agenda for Action*,[6] *A Nation at Risk*,[7] and, *A Report on the Crisis in Mathematics and Science Education*.[8] It received further impetus with the publication by the National Council of Teachers of Mathematics (NCTM) of *Curriculum and Evaluation Standards for School Mathematics*[9] and *Professional Standards for Teaching Mathematics*.[10] The Mathematical Sciences Education Board[11] urges that school mathematics programs be revised and updated to reflect the NCTM "Standards," develop students' mathematical power, use calculators and computers throughout, feature relevant applications, and foster active student involvement. These reports describe mathematical proficiency in a manner that emphasizes reasoning, problem solving, conceptual understanding, and communication.

The Need for New Curriculum in Early Mathematics

The current low success rate for our learners has been with us for many years. If we are to hope for an increase in learner math achievement we need to start doing something differently, which includes improved research-based curriculum and instruction. New research findings supporting the importance of reforming mathematics instruction and call for the development of new mathematics curricula based upon this research. The mathematics curriculum needs to have a balance of structured and unstructured elements. Because our goals for mathematics are broad, the instructional strategies needed to achieve these goals should also be broad and matched to the goals.

Influence of Standards and Alignments to Tests

The public schools were once a trusted institution imbued with authority, where teachers were encouraged to work hard and teach children by following accepted professional standards. But with the development of a technological society, with research on educational outcomes, high expectations, and easily obtained public information this has all changed. The landmark report *A Nation at Risk* made the status of education a front-page issue. A clamor for improvement, beginning with standards, arose from other major events such as the six National Education Goals (1989), establishment of the National Council on Education Standards and Testing (1991), and Congress's enactment of Goals 2000: Educate America Act (1994).

Five critical elements of accountability systems have been widely accepted: rigorous content standards, tests of learner progress, professional development for standards and tests, public reports of learner achievement, and appropriate results for outcomes[12].

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[6] National Council of Teachers of Mathematics. (1980). *An agenda for action: Recommendations for school mathematics of the 1980s*. Reston, VA: Author.

[7] National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform.* Washington, DC: U. S. Government Printing Office.

[8] American Association for the Advancement of Science. (1984). *A report on the crisis in mathematics and science education: What can be done now?* New York: J. C. Crimmins.

[9] National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

[10] National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

[11] Mathematical Sciences Education Board. (1990). *Reshaping school mathematics: A philosophy and framework for curriculum.* Washington, DC: National Academy Press.

[12] Southern Regional Education Board. *Getting Results: A Fresh Look at School Accountability*. Atlanta: Southern Regional Education Board, 1998. 31 pages. ED 426 510.

Standards are commonly understood to apply to core academic disciplines and a high achievement level; they should address what learners should know and be able to do[13].

Trends in State Standards

States have taken up the call and used federal funding to adjust curriculum frameworks to meet the requirements of existing standardized tests or their own criterion-referenced exams.[14] Forty-four of the states have some type of mathematics strategy. Texas, for example, has one of the most recently defined strategies. In Spring 2003, Texas will begin a statewide implementation of the new Texas Assessment of Academic Skills (TASS) II consisting of Texas Mathematics objectives and the Texas Essential Knowledge and Skills (TEKS) or Texas learner expectations. In June 2001, TAAS II was renamed the Texas Assessment of Knowledge and Skills (TAKS). For the school years 2003 –2005, a Grade 3 through Grade 10 TAKS mathematics assessment will be required for learners, and a Grade 11 mathematics Exit-Level Exam will be required for graduation. All TAKS Mathematics exams results will be included in Campus and District accountability. Mathematics instructional materials that align to the new objectives and expectations will be used by learners. The objectives covered in grade levels 3 through 11 are shown below.

TAKS Mathematics Objectives and Results: Grades 3 - 11

Objective	Result
Objective 1	Student will demonstrate an understanding of numbers, operations and quantitative reasoning.
Objective 2	Student will demonstrate an understanding of patterns, relationships and algebraic reasoning.
Objective 3	Student will demonstrate an understanding of geometry and spatial reasoning.
Objective 4	Student will demonstrate an understanding of the concepts and uses of measurement.
Objective 5	Student will demonstrate an understanding of probability and statistics.
Objective 6	Student will demonstrate an understanding of the mathematical processes and tools used in problem solving.

Note that Algebra content is included in objectives at each grade level 3 through 11. The table that follows shows the algebraic content at each grade level. This emphasis on math concepts and principles at every level is characteristic of curricula which follow the NCTM standards (see below).

[13] Gratz, D. B. (2000). *High Standards for Whom?* Phi Delta Kappan 81, 9: 681-87. EA 537 202.
[14] Wraga, W. G. (1999). *The Educational and Political Implications of Curriculum Alignment and Standards-Based Reform.* Journal of Curriculum and Supervision 15, 1: 4-25. EJ 594 857.

TAKS Algebraic Objective 2 Content by Grade Level

Grade Level	Objective 2: Includes the Following Algebraic Content
Grade 3	• (3.6) Student uses patterns to solve problems. • (3.7) Student uses lists, tables, and charts to express patterns and relationships.
Grade 4	• (4.6) Student uses patterns in multiplication and division. • (4.7) Student uses organizational structures to analyze and describe patterns, relationships and algebraic thinking.
Grade 5	• (5.5) Student makes generalizations based on observed patterns and relationships. • (5.6) Student describes relationships mathematically.
Grade 6	• (6.3) Student solves problems involving proportional relationships. • (6.4) Student uses letters as variables in mathematical expressions to describe how one quantity changes when a related quantity changes. • (6.5) Student uses letters to represent an unknown in an equation.
Grade 7	• (7.3) Student solves problems involving proportional relationships in problem situations. • (7.4) Student represents a relationship in numerical, geometric, verbal and symbolic form. • (7.5) Student uses equations to solve problems.
Grade 8	• (8.3) Student identifies proportional relationships in problem situations and solves problems. • (8.4) Student makes connections among various representations of a numerical relationship. • (8.5) Student uses graphs, tables and algebraic representations to make predictions and solve problems.
Grade 9	• A(b)(2) Student uses properties and attributes of functions. • A(b)(3) Student understands how algebra can be used to express generalizations and recognizes and uses the power of symbols to represent situations. • A(b)(4) Student understands the importance of the skills required to manipulate symbols in order to solve problems and uses the necessary algebraic skills required to simplify algebraic expressions and solve equations and inequalities in problem situations.
Grade 10	• A(b)(2) Student uses properties and attributes of functions. • A(b)(3) Student understands how algebra can be used to express generalizations and recognizes and uses the power of symbols to represent situations. • A(b)(4) Student understands the importance of the skills required to manipulate symbols in order to solve problems and uses the

	necessary algebraic skills required to simplify algebraic expressions and solve equations and inequalities in problem situations.
Grade 11 Exit Exam	• A(b)(2) Student uses the properties and attributes of functions • A(b)(2) Student understands how algebra can be used to express generalizations and recognizes and uses the power of symbols to represent situations. • A(b)(3) Student understands the importance of the skills required to manipulate symbols in order to solve problems and uses the necessary algebraic skills required to simplify algebraic expressions and solve equations and inequalities in problem situations.

Other states have either required or will require alignment with mathematics objectives that are similar to those Texas will begin to implement in 2003. Eighteen states have made graduation contingent upon a learner s performance on statewide exit exams. Six states will add such a contingency between 2002 and 2008. Each of those states either does, or will, include math in their exit exams. Of the 18 states, all but one of these states also requires, or will require, learners to pass 10th grade statewide tests to graduate or will have such a requirement by 2008. States among the 18 include Arizona, Florida, Georgia, Massachusetts, New Jersey, New York and North Carolina.

NCTM Standards

Standards for mathematics the development and adoption of standards for mathematics growth and performance has helped to bring a climate of greater agreement among educators regarding issues of mathematics instruction. The resolution, most experts agree, is that no one method is sufficient and that certain elements are critical. Learners need a foundation of skills and strategies, just as they need experience with the full range of contexts where math skills are applied.

The National Council of Teachers of Mathematics (NCTM) standards and the newest NCTM compliant textbooks call for integrating math strands (numbers, algebra, geometry, trigonometry, discrete mathematics, probability, and statistics) and for connecting math concepts to the world. This has led to a significant reshuffling of what is taught and in what order. Among the newest textbooks, NCTM materials, and state graduation standards, there is a fair amount of agreement about what a leamer should know by 4th, 8th grade and by the 12th grade. However, the order in which the objectives are met in grades 1-4, 5-8 and 9-12 is not set. The order is driven by the real-word situations/problems used to teach the relevant concepts and principles.

The NCTM standards have been fairly well received by the National Science Foundation, the U.S. Department of Education and the states as they reviewed or formulated new state standards, new benchmark tests, and new progression and/or exit exams. The NCTM standards have led to the following trends in mathematics education:

- In general, less emphasis on skills for their own sake, more on deep understanding of important concepts that spiral through curricula and are interrelated (fraction, proportion, ratio, scaling, pattems, functions, etc.). In other words, skills follow rather than lead.
- In general, more rich, multi-step problems. For some teachers, instruction is problem-driven, which allows the concepts and skills to be taught in context. For others, the rich problems come with or after formal instruction in concepts, procedures, and skills.

- In general, more emphasis on how math strands (algebra, geometry, measurement, probability and statistics, data collection and analysis, etc) are connected —more integration of the strands at each grade level.
- In algebra, more emphasis on a function-based approach rather than sole use of an equation-based and skills-focused approach.
- The addition of topics from these areas: pattern recognition, data collection and analysis, probability and statistics, functions, and discrete math. Topics from these areas are introduced earlier than in the past, so gaps in these areas are most apparent for grades 6-8.
- In the US, a shift in attention toward the bottom 25% of the class. This shift is largely driven by individual state standards (based on NCTM standards) and the mandated, high stakes tests that determine who passes and who graduates. State testing will accelerate changes in math instruction for the bottom 25% and add pressure to show good results quickly.

Skills-based instruction continues to have content value, as the skills still need to be taught; however, current courseware will engage learners more consistently with attention to the mental models and underlying concepts and principles of mathematics. The curriculum resources mustadopt a more modular organization to accommodate teachers wanting to integrate topics when and as they want/need them. The new math curricula have the following attributes:

Situation or problem-based teaching.
Instruction begins with a real world example rather than teaching concepts in the abstract. For example, graphing an equation is taught to show how real situations can be described by graphing data or graphing the equation that describes the data.

Algebra strand is function-based from the beginning.
The function-based approach is an outgrowth of connecting mathematics to real-world situations. When learners investigate math in the world, concepts such as functions can be introduced earlier.

Process and higher order thinking.
The newest approaches to teaching mathematics have more questions built in that require explaining the processes and thinking behind the solution, or solutions. Math problem solving is designed to provide more modeling, investigating, explaining, and showing multiple solutions

The PLATO early mathematics curricula are based on an extensive and detailed analysis of the implications of state and national (NCTM) standards. The next section provides an overview of the curricula. Following sections examines each of them in more detail.

Part
3

Description of the PLATO Early Math Curricula

The trends in research, standards, and tests discussed in Parts 1 and 2 have guided development of the PLATO® early mathematics curricula. The PLATO® on-line curricula are designed to play an important role as an instructional resource in a complete mathematics curriculum. The flexible, modular structure of the courseware allows correlation to the sequence found in any of the textbooks which align well to state and national standards. Teachers have complete control over selection and sequencing of topics, for extensive adaptation to the requirements of their curriculum and the needs of individual learners. Thus, by using PLATO software, teachers gain the power to use a greatly increased range of strategies to teach each curriculum topic.

PLATO *Math Expeditions* provides age-appropriate, comprehensive coverage of necessary math skills for grades K-6, and addresses state and standardized test objectives and question formats. *Math Expeditions* and the math instruction in *Projects for the Real World* work together to develop mathematical power for all users. Users explore, investigate, reason logically, communicate through mathematics, compute and use problem-solving, mental math and estimation to develop positive attitudes toward mathematics. The *Math Expeditions* and *Projects for the Real World* lessons engage and motivate users and provide opportunities to deepen their understanding of math concepts. . The core early elementary PLATO® resources are *Math Expeditions* Units A through I and *Projects for the Real World* Units A through I. These two curricula are reviewed in detail in this paper.

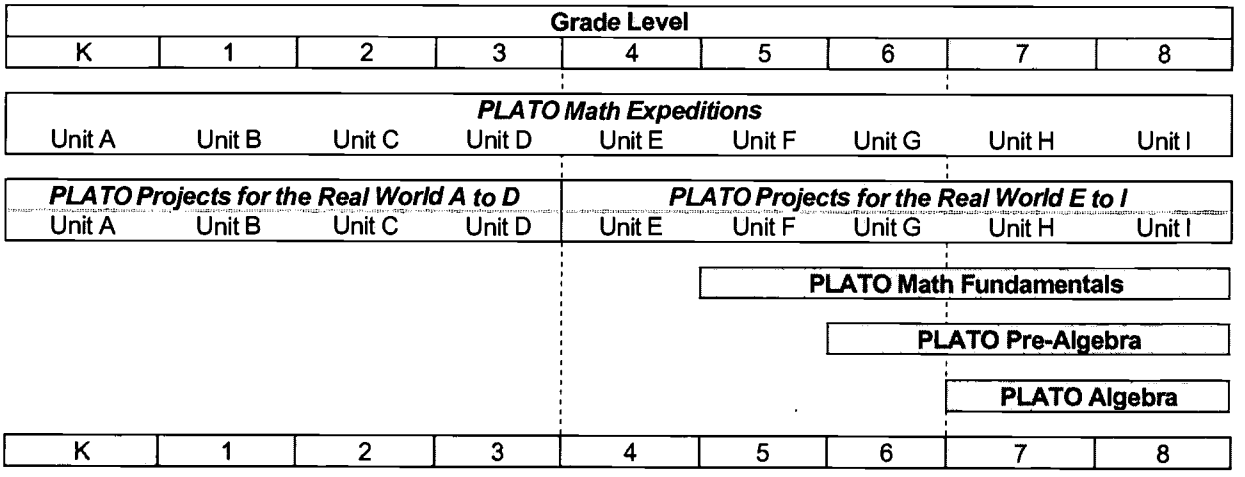
The PLATO Mathematics Curriculum

The PLATO mathematics curriculum not only includes grades K through 6 but extends into secondary grades through level 14. The K through 6 courses can be used with older learners needing remediation. Also for this purpose is PLATO *Math Fundamentals,* a remedial program that is age-appropriate for adults & young adults. For middle school (and even as an option for upper elementary) the pre-algebra and algebra curricula, together with *Math Problem Solving,* provide a strong and age-appropriate core curriculum.[15] Curricula for geometry, trigonometry, calculus, and workplace applied mathematics provide a full solution for secondary, advanced placement, adult, and lower-division post-secondary needs.

An overview of the PLATO early mathematics curriculum is presented in the following figure. Grade-level alignments of course segments represent typical use for regular education learners. However, teachers may judge that regular education learners in higher

[15] The pre-algebra and algebra courses are currently undergoing a major upgrade. A future PLATO technical paper will address the middle school and secondary math curricula fully.

or lower grades might benefit from a particular course segment. Also, advanced or special needs learners might appropriately use a course labeled for another grade level.



PLATO Mathematics Curricula and Mathematics Research

Research on math instruction has shown that effective instruction has a number of characteristics which are incorporated into the PLATO math curricula. A key point is that research supports a pragmatic combination of instructional methods, and does not support one best way to teach mathematics.

Skill Modeling and Practice with Feedback

Research has found that math skills can be effectively taught by direct instruction to provide the conceptual tools for an overall strategy of math problem solving. As stated in Part 1 of this paper, when we use measures of learner achievement on standardized tests of basic skills, one set of models, labeled direct or explicit instruction[16], has developed overwhelming research support in the past 25 years. Typical elements of direct math instruction include starting with a clear explanation of the skill to be learned, the steps involved, how it relates to prior knowledge, and why it is to be learned. Next the learner is given a model of someone correctly applying the skill to a range of relevant problems. Once the learner has a clear grasp of how to proceed, the learner is given ample practice on a similar set of problems. The learner is given corrective feedback in response to each practice attempt to refine his or her performance and to develop insight into the underlying mathematical principles involved. If needed, the learner may go through additional instruction to bring the learner to an adequate performance level.

Manipulatives

Online manipulatives help learners move from the concrete to the symbolic. These tools lend themselves to use with small groups, the entire class, or individual learners. They can also serve as a way to encourage learners to verbalize about their work.

[16] Rosenshine, B. (1995). Advances in research on instruction. The Journal of Educational Research, 88(5), 262-268.

Piaget s work shows that learning is a process of manipulating and mentally transferring real-world experience to symbolism. Although we tend to think of tools and manipulatives as something to be used at the primary level, the use of manipulatives can be equally important for learners at upper grade levels. For example, learners can develop a better understanding of certain fractions concepts such as equivalence and comparison through use of the Fractions, Decimals and Percents tools.

Collaborative Learning

Research shows[17] that through cooperative learning, users learn by interacting with one another in small groups. The PLATO *Math Expeditions* tools and manipulatives provide a very effective venue for cooperative learning. With the tools and manipulatives, users get direct experience with the "why" of a concept, users get to interact and solve problems cooperatively and the teacher can observe and listen as users use on-line tools. This enables the teacher to catch misconceptions right away.

Computation, Mental Math and Estimation

Math Expeditions helps users develop their mental math and estimation skills so these skills become a natural part of their computational processes. They use mental math and estimation skills throughout the lessons, thus developing the ability to think logically.

Problem-Solving

Each *Math Expeditions* lesson begins with a high-interest, real-world problem that motivates users to reason and apply skills to pursue the solution. Team members show processes that work and share their individual strategies for problem-solving. Users sort and classify, find or complete patterns, use information from pictures and graphs, use information from charts and schedules, estimate answers and determine the reasonableness of answers. The math content in *Projects for the Real World* is even more integrated into an authentic real-world project. The multi-disciplinary nature of these problems provides learners the chance to utilize math skills in addressing complex tasks or situations.

Active Learning with Real-World Connections

The interactive tools and manipulatives in the *Math Expeditions* lessons provide the concrete experiences many users need for a thorough understanding of abstract concepts. The users discover for themselves, in a very active way, that mathematics is not simply a collection of numbers that have to be memorized, but a fun way to make sense of everything.

Each *Math Expeditions* lesson features an interesting connection between math and authentic, real-world situations. Sometimes a lesson utilizes multiple representations of math solutions, tying together some combination of computation, estimation, mental math and problem solving. Other lessons ask users to apply math to consumer issues or to a science topic. Whatever the content, the *Math Expeditions* lesson is developing problem-solving sense and asks users at every opportunity to think about what they are doing and to see the concept in a larger context. These connections lead users toward the discovery

[17] Cook, C. (1995). Pathways to School Improvement Critical Issue: Providing Hands-On, Minds-On, and Authentic Learning Experiences in Mathematics. North Central Regional Educational Laboratory. Internet address http://www.ncrel.org/sdrs/areas/issues/content/cntareas/math/ma300.htm.

of a math concept. The connections the users make as they move through the *Math Expeditions* software will cement their understanding of the value and breadth of math.

Curriculum and Mathematics Integration

In *Math Expeditions* and *Projects for the Real World*, a series of cross-curriculum activities that apply skills to several content areas, users make connections to math topics through science, ecology and environmental issues, geography and social studies. Learners are engaged in activities that show how math topics relate to each other and how mathematics is relevant to real-life situations and how subjects are interrelated and interdisciplinary. Learners also discover that mathematics provides insights into other subject areas. Highlighting these other disciplines enriches the users' understanding.

Part
4

Math Expeditions

PLATO Learning s *Math Expeditions* provides comprehensive coverage of the math skills taught in grades kindergarten through sixth grades, with application through the eighth grade level.. This program engages learners and enhances their learning of mathematics by connecting math concepts to fascinating, real-world expeditions where the user begins to see math as an integral and interesting part of life. The expedition adventures span the United States and range from studying wild horses on a barrier island to participating in an inner-city archeological dig in preparation for an underground parking garage.

In *Math Expeditions*, math concepts are presented in the fresh context of socially responsible expeditions. Each user becomes a member of a multi-ethnic, multi-age team going on expeditions that are interdisciplinary and realistic in which math concepts are connected to science and environmental science, social studies, geography and history. Users master basic math skills as they enhance their mental math, estimation and problem-solving skills.

Curriculum Organization

Math Expeditions is divided into nine levels: one level each for kindergarten and grades one through six, with primarily review lessons in levels seven and eight. Each level is contains fourteen to seventeen units (134 for the course) and thirty-five to fifty lessons (399 for the course). Each lesson includes tutorials with interactive demonstrations to introduce and teach the math concept, guided practice to give users ample opportunity to practice the math skill, and reteaching. The Tutorial and Practice sections of most lessons can be completed in a class period. The Quiz and on-line tools and manipulatives may require additional meaningful time. The lessons in *Math Expeditions* provide a total of approximately 480 hours of instruction.

Each lesson is organized into the following parts: Introduction, Tutorial, Practice, Help, and Quiz.

- Introduction presents interesting information regarding the expedition, identifies the math concept to be learned, and connects the math concept to the expedition, thus providing a real world connection for the skill as well as providing a purpose for learning it.
- Tutorial is an interactive lesson in which skills are introduced and taught. These lessons engage users with word problems which connect math concepts to the real world. The user is taken through guided practice in which strategies are modeled by mentors working on similar problems and then practiced by the user. Specific voiced feedback is provided which gives corrective feedback including knowledge of results and further instruction. Specific feedback is provided even for correct input. Characters shown in the tutorials reflect a broad range of ethnic diversity.
- Practice. The Practice session provides ten problems randomly generated from a bank of questions on the skill. The user gets voiced feedback for correct and incorrect responses. Two attempts are provided for each problem if the first try is incorrect. The results of the first try on each quiz problem are sent to the management system.

Users can see a running indicator of their progress through the session; they see the total number of correct answers at the end of the practice session.

- Help. If a user misses two consecutive problems, the program branches to a Help section for re-teaching of the skill with a different presentation or different tutorial. Help is specific to the skill and is presented in a step-by-step format. Animation is used to model the correct procedure and the feedback for correct and incorrect responses is detailed and specific to the problem. After the Help, the user returns to continue the Practice. If two more consecutive problems are missed the user is returned to the Tutorial. If two consecutive problems are missed again after repeating the Tutorial, the user receives a message to, See your teacher for help and the lesson terminates.
- Quiz. The Quiz section of the lesson presents ten questions randomly selected from a bank of 20-30 questions. The user gets only one try to answer a problem. The progress bar displays results on each problem so users can track their progress through the Quiz. No tools are provided for the Quiz section of the lesson. When the quiz is completed, the user sees a results screen which reports number of correct, number tried, and tells the user to go on to another lesson. Quiz scores are automatically reported to the management system to update the user s records.

Instructional Elements

User Input. The *Math Expeditions* lessons are designed to have users interact with the program by entering information in response to questions or problems. The lessons incorporate a variety of age-appropriate input formats. In most cases the lessons require the user to supply the answer. The types of input formats include:

- Fill in the blank. Users type words or numbers in an answer blank or a number box.
- Guided answer input. For this format, users click on any box and input a digit from left to right or right to left. They can also use the tab key to guide them to the next input box when a number of inputs are required. This helps model a logical order in solving multi-step computation problems.
- Selecting options. Users are presented with several options to choose among.
- Matching. By clicking on the match, a line connects the items being matched if the match is correct.
- Drag and drop. Users can click on an object to drag and drop it, such as moving a dot on a number line or moving a number into an answer box.

Mentor Help and Feedback. On-line helps and clues are available from team mentors simply by clicking on the ? on the work pad tool bar. Users receive immediate voiced feedback on all answers.

Pop-up Definitions. The *Math Expeditions* program contains approximately 600 words with pop-up definitions. These words appear in green on the screen and the user can read or hear the definition. These 600 science and geography pop-up definitions build vocabulary in subjects other than math. They are in addition to the math words defined in the lesson —a requirement of many state standards.

Media Design. Throughout the program, graphic images are used that are relevant to the interests of children, visually appealing, and motivating. They add a sense of fun to the learning experience. Professional quality audio is integrated into units and lessons. This allows beginning readers to access lesson content. It also provides support to auditory learners even when they can read the text. Users especially enjoy the realistic voices of the eleven team members as they model strategies and introduce new concepts in step-by-step activities. In levels A-F, all text is voiced. In level G, all feedback throughout the lessons is voiced, and in levels H and I, the feedback in the Practice is voiced. Some audio is voiced automatically as the text appears, but to hear any other text, the user must click on or roll over the text with the cursor.

Animation. Animation is used frequently in the Tutorial and Help sections to provide powerful, active on-line simulations or models of math concepts. These moving images help visualize for the learner representations of what is happening with numbers and shapes so learners truly understand concepts rather than just working the problems by rote. The program provides strong support for visual learners and another means of seeing the concepts for all learners.

Calculator. Learners can access an on-line calculator at any time in the Tutorial, Practice and Help by clicking on the calculator graphic on the Work Pad. Users learn to view the calculator as a useful tool to explore number ideas, determine patterns and to learn concepts quickly without the mechanics of computation getting in the way.

On-line Manipulatives and Tools. Each expedition has a work tent where a rich variety of manipulatives and on-line tools are easily available. The manipulative and on-line tools provide the concrete experiences many users need for a thorough understanding of abstract math concepts. They are appropriate for use with small groups, an entire class or with the individual users. The tools and manipulatives can also serve as a way to encourage users to verbalize about their work.

Users can access a Number Operations Tool for understanding counting, addition, subtraction, multiplication and division. A Money Tool allows users to make change, combine money into larger units, count, add and subtract money. A Number Blocks and Place Value Tool let users understand how numbers are formed and the value of each place. Learners see the money or number blocks they have placed on the screen written in standard form, expanded form, word form and also put in a place value chart. A Fractions, Decimals, Percents Tool lets users place fractional parts into circles or number lines. The fractional parts can be shown as fractions, mixed numbers, decimals and percents.

In addition to the many tools accessed from the work tent the tutorials contain interactive tools that make learning math an active process. Some of the many interactive tools found in the lessons are:

- Number Line
- Thermometers
- Clock
- Rulers
- Coordinate Grid
- Measuring Devices
- Balance Scale
- Rotator to slide, flip and turn shapes
- Spinners
- Cubes

Using *Math Expeditions* in Your Curriculum

Teachers have complete flexibility to select and sequence the components of *Math Expeditions* in an optimum learning path. Learners must do units and lessons in the order specified by the learning path unless the teacher has selected an exploratory option in the management system. The exploratory option lets the user do the units and lessons in any order. For optimum use, it is recommended that users proceed through the lessons in the order in which they appear in the unit. Each lesson assumes the user has mastered the previous skill.

The lessons allow bookmarking, so learners can interrupt a lesson any time and resume later where they left off.

Assessment and Reporting

The Practice and Quiz problems of each lesson in *Math Expeditions* are scored and learners will immediately see if they solved a problem correctly. In the Practice section the learner will receive immediate audio feedback and will see mastery or non-mastery of each question marked in the Progress Bar located on the desktop. This gives the teacher a detailed profile of each learners understanding of each concept. The scoring of each Quiz problem will be displayed in the Progress Bar and the quiz score will be sent to the management system. Teachers can get user scores and other information, such as time spent on task and mastery/non-mastery, by viewing this information on-line or by printing reports.

What Does It Teach?

Each level in *Math Expeditions* addresses a grade-appropriate set of math skills across the following areas:

- Number Recognition
- Numeration
- Addition
- Subtraction
- Multiplication
- Division
- Time
- Money
- Measurement
- Fractions and Mixed Numbers
- Decimals
- Ratios, Proportions, Percents
- Geometry
- Graphing
- Statistics
- Probability

The specific skills taught in each level (grade level) are listed in the following table.

Math Expeditions Levels A to I

Project	Activity
Math A —Pacific Tide Pools (Kindergarten)	
Numeration —Position	Locate objects: inside, outside, on Locate objects: left, right Locate objects: after, between Locate objects: nearest, farthest Locate objects: above, below
Numeration —Classify	Identify objects: same size Identify objects: same color/shape
Numeration —Recognition	Identify groups of one, two, three Identify groups zero through seven Identify groups of 8 through 12 Identify groups of 11 through 19 Identify groups of 20 through 29
Numeration —Ordinals	Identify ordinals through fifth
Numeration —Compare	Same, more, fewer One more, one fewer, as many as
Numeration —Order	Order numbers 1 through 10 Order numbers 11 through 19 Order numbers through 31
Number Operations —Addition	Join two groups: identify total Add two numbers: sums to 6
Number Operations —Subtraction	Remove objects from group Subtract numbers through 9

Project	Activity
Fractions —Fractions	Equal parts of whole and one half
Money —Money	Identify value penny, nickel, dime
Time —Time	Tell time to the hour
Measurement —Length	Length using informal units
Measurement —Mass, Weight	Objects - heavier
Measurement —Capacity	Which holds more or less?
Geometry —Geometry	Circles, squares, triangles
Math B —Buffalo National River (Grade 1)	
Numeration —Number Recognition	Identify and count 0-6 Identify and count 7-12 Count by fives
Numeration —Ordinals	Identify ordinals through tenth
Numeration —Compare	Compare numbers through 99
Numeration —Order	Order numbers 1 through 10 Order numbers through 99
Numeration —Place Value	Identify tens and ones to 99 Identify and write tens to 90
Number Operations —Addition	Add two numbers with sums to 10 Add with zero Add three numbers with sums to 10 Add two numbers with sums to 12 Add two 2-digit numbers Add with money
Number Operations —Subtraction	Subtract numbers through 7 Subtract with zero Subtract numbers 9, 10, 11, 12 Subtract with two 2-digit numbers Subtract with money Subtract numbers 13 through 18
Fractions —Fractions	Identify 1/2, 1/3 & 1/4
Money —Money	Identify coins to 99 cents
Time —Time	Tell time to the half hour
Measurement —Length	Measure with an inch ruler
Measurement —Mass, Weight	Measure weight; use pounds
Measurement —Capacity	Convert cups, pints, quarts
Geometry —Geometry	Triangles/rectangles/circles/squares Cubes/cylinders/spheres/cones
Graphs —Graphs	Solve problems: use a bar graph
Math C —Rocky Mountain (Grade 2)	
Numeration —Number Recognition	Count by twos; even numbers Count by twos; odd numbers
Numeration —Ordinals	Identify ordinals to twentieth
Numeration —Compare	Compare numbers through 99
Numeration —Order	Order numbers through 99
	Order numbers through 999
Numeration —Place Value	Identify tens & ones to 99 Write standard form to 99 Write standard form to 999

Project	Activity
Numeration —Round	Round numbers to nearest ten
Number Operations —Addition	Add two numbers with sums to 10 Add two numbers with sums to 12 Add three numbers with sums to 12 Add two numbers with sums to 18 Add threes numbers with sums to 18 Add a 1-digit to a 2-digit number Add two 2-digits; no renaming Add two 2-digits using money
Number Operations —Subtraction	Subtract numbers through 12 Subtract numbers through 18 Renaming readiness Subtract 2-digit numbers; rename Subtract multiples of 10; rename Subtract two 2-digits; rename Subtract with money Subtract 3-digit numbers
Number Operations — Multiplication	Multiply by twos Multiply by threes Multiply by fours Multiply by fives
Fractions —Fractions	Halves, thirds, fourths, tenths
Money —Money	Compare money to $2.00
Time —Time	Tell time to 5 minuets
Measurement —Length	Identify units of length
Measurement —Mass, Weight	Metric units of mass
Measurement —Capacity	Identify units of capacity
Geometry —Geometry	Identify plane shapes Identify solid shapes
Graphs —Graphs	Solve problems: pictographs
Math D - Puffin Island (Grade 3)	
Numeration —Compare	Compare numbers to 999 Compare numbers to 9999
Numeration —Order	Order numbers to 999 Order numbers to 9999
Numeration —Place Value	Write standard form to 999* Write standard form to 9999 Write standard form to 999,999
Numeration —Round	Round numbers to tens Round to tens and hundreds
Number Operations —Addition	Add two numbers with sums to 18* Add three 1-digit numbers to 18* Add 2-digit plus 1-digit numbers Add two 2-digit numbers Estimate sums Add three or more 1-digit numbers Add three or more 2-digit numbers Add two 2, 3, or 4-digit numbers Add money

Project	Activity
Number Operations —Subtraction	Subtract numbers 13 to 18* Subtract 1D from multiples of 10 Subtract 2D from multiples of 10 Subtract two 2-digit numbers Estimate differences Subtract 3-digit numbers Subtract 4-digit numbers Subtract with money
Number Operations — Multiplication	Multiply with zero through five Multiply with fives and sixes* Multiply with sevens and eights* Multiply with nines* Multiply with multiples of 10 Estimate products* Multiply 2-digit by 1-digit numbers* Multiply 3-digit by 1-digit numbers* Multiply with money*
Number Operations —Division	Divide by 2-5 Divide by 6-9 Divide by 1-9 Divide by 1-digit, with remainders Divide tens & hundreds by 1-digit Divide by 1-digit numbers Divide 3-digit by 1-digit numbers
Fractions —Fractions	Add and subtract fractions Equivalent fractions
Decimals —Decimals	Add and subtract decimals
Money —Money	Solve problems; estimate money
Time —Time	Tell time to the minute Solve problems; calendar
Measurement —Length	Identify units of length
Measurement —Capacity	Identify units of temperature
Geometry —Geometry	Determine perimeter of a polygon Polygon area by counting squares
Graphs —Graphs	Solve problems: bar graph, pictograph
Math E —Red Rock (Grade 4)	
Numeration —Compare	Compare numbers to 999,999
Numeration —Order	Order numbers to 999,999
Numeration —Place Value	Identify place value to millions
Numeration —Round	Round numbers to 999,999
Number Operations —Addition	Use mental math to add Estimate sums Add two or more numbers
Number Operations —Subtraction	Subtract numbers 13-18 Estimate differences Subtract 2 or 3-digit numbers Subtract 4 or 5-digit numbers
Number Operations — Multiplication	Multiply with zero through five Multiply with fives and sixes

Project	Activity
	Multiply with sevens and eights Multiply with nines Multiples and common multiples Estimate products Multiply by 1-digit numbers Multiply 3-digit by 1-digit numbers Multiply using money Multiply 4-digit by 1-digit numbers Multiply 2-digit by 2-digit numbers Multiply 3-digit by 2-digit numbers
Number Operations —Division	Divide by 1-9 with remainders Divide 2-digit by 1-digit with remainders Divide 3-digit by 1-digit with remainders A Divide 3-digit by 1 digit with remainders B Dividing money Divide by 2-digit with remainders A Divide by 2 digit with remainders B Estimate quotients
Fractions —Fractions	Equivalent fractions & lowest terms Add & subtract same fractions Compare equivalent fractions Add & subtract different fractions
Decimals —Decimals	Write decimals Compare, order & round decimals Add & subtract decimals
Measurement —Length	Metric units of length
Measurement —Capacity	Metric units capacity, mass, temperature
Geometry —Geometry	Classify points, lines & angles Identify geometric shapes Find the perimeter Find the area
Graphs —Graphs	Data from graphs
Math F - Cumberland Island (Grade 5)	
Numeration —Compare	Compare numbers to 999,999*
Numeration —Order	Order numbers to 999,999*
Numeration —Place Value	Identify place value to millions*
Numeration —Round	Round through millions
Number Operations —Addition	Add two or more numbers* Estimate sums Add large numbers
Number Operations —Subtraction	Estimate differences Subtract numbers up to 6-digits Subtract numbers with zeros
Number Operations — Multiplication	Multiply 3 & 4 digits by 1-digit Multiply using money Multiplying by tens and hundreds Estimate products Multiply 2-digit by 2-digit numbers* Multiply 3-digit by 2-digit numbers

Project	Activity
	Multiply by 3-digit numbers
Number Operations —Division	Divide 2-digit by 1-digit with remainders* Divide 3-digit by 1 digit with remainders A* Dividing money* Divide 3-digit by 1-digit with remainders B* Divide 3-digit and 4-digit by 1-digit with 0 Divide 2 and 3 digit by multiples often Divide by 2-digits with remainders Divide 4-digit by 2-digit A Divide 3-digit and 4-digit by 2-digit B Estimate quotients*
Fractions —Fractions	Add & subtract same fractions* Add & subtract different fractions* Add mixed numbers Subtract mixed numbers Multiply fractions & mixed numbers
Decimals —Decimals	Compare, order & round decimals* Add & subtract decimals* Multiply decimals Divide decimals
Ratio/Proportion — Ratio/Proportion	Decimals & fractions as % Write ratios
Measurement —Length	Metric units of length*
Measurement —Capacity	Metric units capacity, mass, temperature*
Geometry —Geometry	Classify points, lines & angles* Identify geometric shapes* Measure angles* Locate coordinate points Find the perimeter* Find the circumference Find the area* Identify congruent & similar Find the volume
Graphs —Graphs	Data from graphs
Probability —Probability/Stats	Range, median, mode & mean*
Math G —Everglades (Grade 6)	
Numeration —Compare	Compare numbers to millions
Numeration —Order	Order numbers to millions
Numeration —Place Value	Identify place value to billions Recognize place value in decimals
Numeration —Round	Round numbers through millions Round decimals
Number Operations —Addition	Add numbers up to 3-digits Estimate sums Add numbers up to 6-digits
Number Operations —Subtraction	Subtract 1, 2, or 3-digit numbers Subtract numbers up to 6-digits Estimate differences Subtract numbers with zeros

Project	Activity
Number Operations — Multiplication	Multiply by 1-digit numbers Multiply by 2, 3, 4-digit numbers Estimate products
Number Operations —Division	Divide up to 5-digits by 1-digit numbers Divide 3, 4, or 5-digits by 1-digit number 3D, 4D divided by 2-digit, multiples of 10 2D, 3D divided by 2-digit, 1-digit quotient* Divide by 2-digits, 2-digit quotient 3, 4, 5-digits divided by 2-digits 4, 5, 6-digits divided by 3-digits Estimate quotients
Fractions —Fractions	Compare & order fractions Add & subtract different fractions* Add mixed numbers* Subtract mixed numbers* Multiply fractions & mixed numbers* Divide fractions
Decimals —Decimals *	Add and subtract decimals Multiply decimals Divide decimals
Ratio/Proportion — Ratio/Proportion	Decimals & fractions as %* Write ratios* Solve rates & proportions Find percents Solve percents
Geometry —Geometry	Classify points, lines & angles* Identify geometric shapes* Measure angles* Locate coordinate points Find the perimeter Find the circumference* Find the area Identify congruent & similar Find the volume* Find the surface area
Graphs —Graphs	Data from graphs
Probability —Probability/Stats	Range, median, mode & mean
Math H —Aransas Refuge (Grade 7)	
Numeration —Compare	Compare numbers to millions Compare numbers & decimals
Numeration —Order	Order numbers to millions* Order numbers & decimals
Numeration —Place Value	Identify place value to billions* Recognize place value in decimals
Numeration —Round	Round numbers through millions Round decimals
Number Operations —Addition	Add numbers up to 6-digits Estimate sums Add decimals

Project	Activity
Number Operations —Subtraction	Subtract numbers up to 6-digits Estimate differences Subtract decimals
Number Operations — Multiplication	Multiply by 1-digit numbers Multiply by 2, 3, 4-digit numbers* Estimate products Multiply decimals
Number Operations —Division	Divide whole numbers Divide a decimal by a whole number Divide by decimals Estimate quotients
Fractions —Fractions *	Compare & order fractions Add & subtract different fractions Add mixed numbers Subtract mixed numbers Multiply fractions & mixed numbers Divide fractions
Decimals —Decimals *	Add & subtract decimals Multiply decimals Divide decimals
Ratio/Proportion/% — Ratio/Proportion/%	Decimals & fractions as percents* Write ratios* Solve rates & proportions* Find percents* Solve percents* Find numbers from percents
Geometry —Geometry	Classify points, lines & angles* Identify geometric shapes Measure angles* Locate coordinate points* Find the perimeter* Find the circumference* Find the area Identify congruent & similar* Find the volume Find the surface area*
Graphs —Graphs	Data from graphs
Probability —Probability/Stats	Range, median, mode & mean* Find the probability & outcomes
Math I —Archeology (Grade 8)	
Numeration —Compare	Compare numbers to millions Compare whole numbers & decimals Compare rational numbers
Numeration —Order	Order numbers to millions* Order numbers & decimals Order rational numbers
Numeration —Place Value	Identify place value to billions* Recognize place value in decimals Write in scientific notation

Project	Activity
Numeration —Round	Round numbers through billions Round decimals
Number Operations —Addition	Add numbers up to 6-digits Estimate sums Add decimals
Number Operations —Subtraction	Subtract numbers up to 6-digits* Estimate differences Subtract decimals
Number Operations — Multiplication	Multiply by 1-digit numbers Multiply by 2, 3, 4-digit numbers* Estimate products* Multiply decimals*
Number Operations —Division*	Divide whole numbers Divide a decimal by whole number Divide by decimals Estimate quotients
Fractions —Fractions *	Compare & order fractions Add & subtract different fractions Add mixed numbers Subtract mixed numbers Multiply fractions & mixed numbers Divide fractions
Decimals —Decimals *	Add & subtract decimals Multiply decimals Divide decimals
Ratio/Proportion — Ratio/Proportion/%*	Decimals & fractions as % Write ratios Solve rates & proportions Find percents Solve percents Find numbers from percents
Geometry —Geometry *	Classify points, lines & angles Identify geometric shapes Measure angles Locate coordinate points Find the perimeter Find the circumference Find the area Identify congruent & similar Find the volume Find the surface area
Graphs —Graphs	Data from graphs
Probability/Stats — Probability/Stats*	Range, median, mode & mean Find probability & outcomes

* These upper level lessons are for review of skills needed to complete other activities within the level. They reteach concepts presented at lower levels, and repeat problems encountered in earlier lessons.

Part

5

Projects for the Real World A to I

Projects for the Real World is designed to give elementary and middle grade learners authentic practice in applying concepts of

- Numeration —Classify, Compare, Number Recognition, Order, Ordinals, Place Value, Position, Recognition, Round
- Number Operations —Addition, Subtraction, Multiplication, Division
- Fractions —Fractions
- Money —Money
- Time —Time
- Measurement —Length, Capacity, Mass, Weight
- Geometry —Geometry
- Graphs —Graphs
- Decimals —Decimals
- Ratio/Proportion —Ratio/Proportion, Ratio/Proportion/Percent
- Probability —Probability, Probability/Statistics

These cognitive skills are integrated with each other and with concepts of real life skills and social and emotional attitudes . Learners receive a special focus on their relationship to others and the environment. The interdisciplinary approach offers learners many opportunities to understand how concepts and tasks fit together. The multimedia nature of the program engages children by allowing them to hear text being read (in levels A-D) or read and then to respond in multiple ways to questions and assignments. In levels E-I clues are available and mentors share how they would solve the problem. When learners give answers they receive immediate feedback about their correctness; in many cases they are told why an answer is wrong or how to arrive at a correct answer.

Course Organization

Projects for the Real World is divided into four levels for the primary grades, Levels A through D, and five levels for the intermediate grades, Levels E through I. Math instruction in these levels is designed for kindergarten through third grade and fourth through eighth grade, respectively.

For each level, K-8, math topics are integrated with reading and language arts. Especially in the first four levels, these academic topics are presented on a backdrop of real world settings that make it possible to also include real life skills and social and emotional skills.

In Levels A to D there are 26 units, 104 projects, and 485 activities. Assuming that the average project takes a little more than one class period to finish, the total course Levels A to D provides approximately 104 hours of problem solving, math instruction, and practice. The levels and their projects are listed below:

- Level A: *Me; Let s Get Organized; Messages Without Words; I Can Make a Difference; Buy Me! Buy Me!; I Love Animals; Getting Around*

- Level B: *Plants and Seeds; Working Together; Gift Giving and Appreciation; Fund-raiser; Money; Pets; Grow a Garden*
- Level C: *Maps; Make a Collection; So Many Ways to Communicate; Fabulous Trees; Keeping Healthy; Neighborhood Animals*
- Level D: *Body; Books and More; Problem Solving; Endangered Animals; Smart Shopper; World of Insects*

Levels E through I, planned for grades four through eight, allow for developing maturity and vocabulary of intermediate learners. Ascending levels use progressively fewer auditory options as they introduce topics that are more scientific and broad in their scope. Interactivity with the screens is progressively more focused on content, both for topics and for skills in reading, English, and math. In Levels E to I there are 20 units, 141 projects, and 308 activities. Assuming that the average *activity* takes one class period to finish, the total course, Levels E to I, provides approximately 250 hours of problem solving, math instruction, and practice.

- Level E: *Home Health Detective; State Visitors Center; News Desk; Desert Survival*
- Level F: *School Proposals; Food Bank; Designing a Museum; Climbing Mt. McKinley*
- Level G: *Volunteering; Yellowstone Connection; Make TV Work for You; Olympic Games*
- Level H: *All Kinds of Families; Medical Mix-Up; Consumer Guide; Maya Mystery*
- Level I: *Earning Money; Trouble in Camelot; Making a Video; Space Center*

At each level, all of these units have four projects, or themes, for which usually four to six activities are provided. Each activity has multiple scenes that require learners to apply various skills. Activities provide authentic tasks multiple strategies for involving learners, such as a picture with objects or words that can be moved or a graph to be drawn or analyzed and compared to other data. Activities include a variety of learning activities: naming and labeling, sequencing, recall, analysis, discrimination, categorization, prediction, and inference. In Levels E through I there are multi-step procedures.

Below is a description of a typical unit in Levels A through D. In Levels E through I there is more complexity in how the unit is organized.

- *Introductory Screens*. When starting a unit, learners see introductory screens and an Opening Unit Photo . Learners may click on children in the photo (drawing), whereupon the characters make a statement or ask a question for anticipatory set.
- *Survey questions*. Next is a survey that presents a few organizing questions on a clipboard (which is a standard format throughout *PRW*). These questions can also be used at the end of each unit to demonstrate to learners what they have learned.
- *Story or rhyme*. A story or rhyme is then given; learners may click on parts of the picture for the text of a story or sentence that is read. If there is a personal letter, for instance, a click on it will elicit an audio reading of the text.
- *Work plan*. When the work plan appears, learners may choose which project they want to do first, i.e., the topic they would like to work on first.
- *Project*. Each project has one theme and includes from four to six activities on that theme. Activities are involving.
- *Activity*. Each activity has one or more screens; each screen uses involvement of various kinds to address content.

Integrated into activities are topics and activities that support positive social and emotional development for children. Repeatedly, text and modeling are used to demonstrate the concepts of cooperation, self-esteem, mutual respect, understanding the feelings of others, problem solving, and sharing.

In levels A through D, the following topics are presented in various activities:

- Math Vocabulary
- Number, Counting, and Number Sequence
- Sorting, Classifying, Patterns
- Measurement
- Operations
- Data Collection and Presentation
- Estimation
- Problem Solving

In levels E through I, topics within the following categories are progressively more advanced:

- Arithmetic Skills Whole numbers and fractions; decimals, percents, and proportion; and computation and estimation.
- Measurement Estimation, exact measurement, calculation.
- Data Analysis Reading and making tables, charts, graphs, schedules, maps, bar graphs; map use; graphical models; statistical methods. Data collection, analysis, representation, interpretation, inference.
- Math Application/Mathematical Process Math concepts and strategies applied to problem-solving in a variety of real world situations, many requiring multi-step problems. Deductive and inductive reasoning; statistical understanding; and mathematical thinking and modeling to solve problems in other disciplines.

Instructional Elements

In *Projects for the Real World,* Levels A through D, learners listen to text of math problems being read in a variety of settings. Some of the text is provided by the Wasatch Kids as they ask questions and make comments; some text is read by a narrator. As learners participate in an activity, they listen, read, and speak; they also move words, phrases, and sentences to label objects, answer questions, complete question formats, and organize text. Tools that learners may use are a painter, writer, calculator, timer, and recorder. *Projects for the Real World* provides a math workroom where learners can use several work areas:

- Information Center
- Writing Ideas Center
- Arts and Crafts Ideas Center
- Learner s Portfolio
- Game Center
- Library Center
- Recording Center
- Data Decks
- Catalogs

No matter the level, *Projects for the Real World* continue to make use of brilliant colors, multiple characters, and interactive screens. Interest is maintained in a variety of ways. First of all, learners can be self-directed in their learning. While they are in an activity they can review former screens at will. Unless learners are directed to complete certain projects and activities, there are frequent choices for them to make; thus, they may follow their interests. They can find additional information through the system. Secondly, between levels and within activities, activities are structured to start with concrete learning and progress to high levels such as analysis. Third, multiple topics are intertwined throughout, making the exercises multifaceted and integrated. Vocabulary, reading, English, and math concepts are introduced in relation to the umbrella topic. Learners learn skills while the context of the topic makes skills more meaningful. For example, many activities require hands-on work before learners can give an answer. Fourth,

program features such as the ability to print pictures and products makes the computer a more useful tool for learning.

In addition, each project has a list of more things the learners can do off-line to further pursue the theme being studied. The projects also provide a list of additional readings a learner can do off-line for additional learning. Learner activity books are provided for each level to provide additional off-line learning activities in connection with the projects being studied. The off-line work provides added opportunities to practice and apply content skills studied on-line.

Using the *Projects for the Real World* In Your Curriculum

As they use *Projects for the Real World,* primary learners are engaged not only in reading but also in doing math, listening, speaking, and writing. Levels E through I give learners many experiences in learning math concepts and applying them in rule-using exercises, comparisons, analysis, and problem solving. These experiences require attention for all levels of learning. The activities give immediate feedback, which strengthens learner understanding and increases their desire to participate. At all grade and performance levels, social and emotional development references can help to teach or reinforce attitudes and behaviors that are desirable for children and youth. The hands-on math work in specific settings is interesting and even exciting for many learners.

Teachers may use *Projects for the Real World* for experience in first-time learning of math concepts, applying math concepts already learned to a real-world situation, or as further practice in skills and understanding that have been introduced in other classroom settings. In addition, unit activities can be integrated with other classroom work, such as library exploration and development of term papers.

Assessment and Reporting

Learners receive immediate feedback on program-generated work. For teachers, the management system reports scores on each math activity. It also provides the number of activities completed by each learner and the time spent on each activity. The program will print learner products like drawings, charts, graphs, thus letting learners show their success and encouraging learner pride in their work. These pages can be added to learner portfolios for formal and informal assessment using a variety of results. Checklists are provided to aid teacher assessment.

PROJECTS FOR THE REAL WORLD GRADES K-8 (Levels A-I)

Units	Skill	Topic. Number of activities in which it is used
Level A (Kindergarten)		
Unit 1: Getting Around Unit 2: Messages Without Words	Math Vocabulary	Uses relative size words. 2 Uses shape names. 1 Uses color words. 1 Learns words for various real life items containing numbers. 1 Learns measurement vocabulary. 1 Compares relative heights, weights, speeds. 1 Identifies heaviest or lightest objects. * Recognizes spatial concepts. * Recognizes the concept of more. * Recognizes the concept of fewer. *
Unit 3: Lets Get Organized Unit 4: Buy Me! Buy Me! Unit 5: Me Unit 6: Make a Difference Unit 7: I Love Animals	Number, Counting, and Number Sequence	Uses one-to-one correspondence. 2 Matches sets. 1 Matches numeral with appropriate set. 1 Counts to 10. 8 Counts to receive information. 1 Orders numbers. 2 Plays a counting board game. 2 Counts money. 1 Matches like sets. * Writes numbers. (1-10) * Fills in the missing set within a sequence. * Identifies ordinal placement-first through fourth and last.* Counts 1-25. * Counts by tens. * Writes numbers 1-10. * Identifies sets with 0 members. * Draws to illustrate the number in a set. *
	Sorting, Classifying, Patterns	Categorizes to one attribute. 14 * Sort letters and numbers. 1 Sorts according to color. *
	Measurement	Measures using a tape measure or ruler. 1 Interprets calendar record keeping. 1 Uses a calendar to record information. 1 Practices counting money. 2 Orders pages in a book, numbers on a ruler, and numbers on a calendar. 1 Orders according to height. 1 Orders according to weight. 1 Orders according to speed. 1 Identifies the cost in pennies 1c 10c. * Identifies time to the hour * Writes amounts for pennies, nickels, and dimes. * Identifies the items that cost more. 1c —25c. * Identifies the items that cost less. 1c 25c. * Measures to the nearest inch. * Identifies the tallest child. *

Units	Skill	Topic. Number of activities in which it is used
	Operations	Adds single digit numbers 1 Check for more Practices adding and subtracting money amounts. 1 Uses addition to complete a grid. 1 Compares costs. 1 Adds amount needed to get to a designated amount.* Adds two sets. * Determines how many objects are left after some are eliminated. * Adds one more to determine total in sets. *
	Data Collections and Presentation	Writes numbers. 1 Writes numbers to share information. 1 Organizes a room. 1 Creates a number book. 1 Recognizes ordinal placement. 1 Makes a schedule. 1 Interprets a graph. 1 Completes and interprets a survey. 1 Organizes a drawer. 1 Makes a number book. 2
	stimation	Estimates what the future may bring. 1 Estimates a number needed. 1 Estimates heights, weights, and speeds. 1
	Problem Solving	Identifies real life numbers. 1 Interprets schedule. 1 Figures out how many more are needed. 1 Figures out appropriate solutions to problems. 1 Determines amount needed. 1 Goes on a treasure hunt to find certain real life numbers. 1 Completes a grid to find cost of multiple items. 1 Determines best price. 1 Play and carries out a mini-toy sale. 1 Solves problems through the process of elimination. 1 Completes a maze. 1 Constructs a maze. 1
Level B (Grade 1)		
Unit 1:Plants and Seeds Unit 2: Working Together Unit 3: Gift Giving & Appreciation Unit 4: Fund-Raiser Unit 5: Money Unit 6: Pets Unit 7: Grow	Math vocabulary	Identifies *most.* (1-50) * Identifies *fewest.* (1-50) * Demonstrates understanding of *small, medium,* and *large.* * Demonstrates understanding of *more* and *less.* * Demonstrates understanding of halves, quarters, and thirds. * Names coins (penny, nickel, dime, quarter). 20
	Counting and Number Sequence	Counts by twos. 1 * Counts by fives. 2 * Counts by tens. 2 * Counts by twenty-fives (quarters). 1 Counts forward to solve a problem. 1 Orders and writes numbers (1-31). *
	Patterns	Creates a pattern. 1 Continues a pattern. 1* Labels a pattern. 1 Corrects errors in a pattern. 1 Copies a symmetrical pattern. 1
	Sorting and Classifying	Categorizes with one attribute. 5 * Develops categories for sorting. Sorts coins by type. (penny, nickel, dime, quarter) 2 *

Units	Skill	Topic. Number of activities in which it is used
	Measurement (time, money, measuring tools, fractions)	Plays a board game to add money amounts. 1 Measures using a ruler. * Uses tape measure to measure. * Uses a calendar to show data. 1 Uses calendar. 3 Makes a calendar. 1* Orders months. 1 Makes a recipe. 1 Orders days of the week. * Creates fourths, halves, and thirds. * Finds 1/2 of a number. 1 Counts money to $1.00. 2 (Also see the Money Unit activities under Operations.)
	Operations	Adds two two-digit numbers. 2 * Adds three two-digit numbers. 1 * Adds 4 one-digit addends. 2 * Supplies missing addends. * Subtracts to get desired amount. * Subtracts one-digit numbers. * Subtracts two-digit numbers. * Identifies a "fair trade." 3 * Creates a "fair trade." 3 Demonstrates value of penny, nickel, dime, quarter. * Shows different ways to make 5 cents. 1 Shows different ways to make 10 cents. 1 Shows different ways to make $1.00. 2 Counts money using dollars and coins. 5 * Shows how to solve a problem in different ways. 2 Makes change. 1 Works with place value to two places. 1
	Data Collection and Presentation	Compares amounts (5-25). * Sorts into equal groups. 2 Tallies votes. 1 Conducts and reports a survey. 1 Interprets graphs. 1 Completes a grid. 2 Conducts a survey. 1 Interprets voting results. 2 Infers results from graph. 2 * Uses a graphing tool. 1 Makes a display of information. 1 Uses a table tool. 1
	Estimation	Estimates quantities. 4* Estimates approximate cost of gifts. 1 Estimates length of time. 1 Estimates costs. 1
	Problem Solving	Solves everyday problems. 20* Solves addition story problems. 14 Solves subtraction story problems. * Solves a problem in different ways. 6 Creates word problems. 1 Completes two-step problems. * Finds _ of a number. 1

Units	Skill	Topic. Number of activities in which it is used
Level C (Grade 2)		
Unit 1: Maps Unit 2: Make a Collection Unit 3: So Many Ways to Communi-cate Unit 4: Fabulous Trees Unit 5: Keeping Healthy Unit 6: Neighbor-hood Animals	Math Vocabulary	Uses map symbols and labels. 15 Uses concept of rule as it relates to categorizing. 16 Uses labels for collections. 21 Recognizes parts of an address. 1 Recognizes words for months. 1 Reviews words for seasons. 1 Learns to define serving amounts. 1 Illustrates words describing amounts.* Matches units of measurement with appropriate pictures. *
	Number, Counting, and Number Sequence	Counts distances. 1 Sequences order of story. 3 Counts items. (1-100) 1 Completes a symmetrical design. 1 Makes your own pattern or design.1 Sequences parts of a letters. 1 Uses numbers to make a tune. 1 Makes a tree celebration tune. 1 Enters data to complete' a table. 1 Counts heartbeats. 1 Counts by 2's. *
	Sorting, Classifying, Patterns	Categorizes to one attribute. 7 Creates rules/system for sorting. 3
	Measurement Fractions	Reads to get information about time. 1 Explores spatial relationships. 16* Counts money to determine totals. 1 Plans time. 1 Begins to understand gram as a measurement. 1 Uses the timer. 2 Measures elapsed time. 1* Creates a symmetrical pattern. * Adds amounts of time. * Determines square feet of an area. * Compares areas. * Determines fair trade amounts of money. * Determines 1/2 of an amount of money. * Determines mileage on a map. *
	Operations	Finds the missing addend (1-10) 1 Finds the missing addend (1-100) 1 Finds the missing addend (1-1000) 1 Creates a fair trade. 1 Multiplies to solve problems. 1 Recognizes fair trades. * Determines differences to complete a table. * Writes how to solve a problem. 1 Adds four two-digit numbers. * Adds three three-digit dollar amounts. * Adds two two-digit numbers with regrouping. * Chooses correct operation for a story problem. *

Units	Skill	Topic. Number of activities in which it is used
	Data Collections and Presentation	Presents information. 7* Makes a telephone book. 1 Interprets a graph. 2* Creates a newsletter format. 1 Makes an exercise chart. 1 Interprets a survey. 1 Takes a survey. 1
	Estimation	Estimates distances. 1 Estimates amounts. 2 Estimates worth. 1 Estimates sums to estimate biggest total. *
	Problem Solving	Multiple topics. 15*
Level D (Grade 3)		
Unit 1: Body Unit 2: Books and More Unit 3: Problem Solving Unit 4: Endangered Animals Unit 5: Smart Shopper Unit 6: World of Insects	Math Vocabulary	Learns words that are used in a sales pitch. 1 Learns words that relate to budgeting. 1 Learns the vocabulary that explains usual printed labeling. 1 Learns what "splitting the difference means. 2 Learns simple fractions. * Learns money terms for earning money and profit. *
	Number, Counting, and Number Sequence	Completes patterns. 1* Makes number patterns. 1* Matches words representing large numbers with the appropriate numeral. * Counts to interpret graphs. *
	Sorting, Classifying, Patterns	Categorizes to one attribute. 7 Continues number patterns. *
	Measurement/ Fractions	Uses symmetry to construct a skeleton. 1 Explores a map. 1 Follows directions that relates to fraction. 1 Determines 1/2 of an amount of money. 1 Divides items into the appropriate fractional part. * Recognizes fractions that are represented in a circle graph. * Determines elapsed time.* Discovers errors in a story that relate to the measurement of time. *
	Operations	Calculates costs. 1 Multiplies (or adds) to solve a problem. 1* Finds differences. 1 Uses addition and subtraction to solve problems. 2 Adds tax to the cost of items. 1 Uses a graph to compare amounts. 1 Subtracts to solve a problem. (2-digit) 1 Selects the operation needed to solve a story problem. (+ or) * Selects the operation needed to solve a story problem. (x or division) * Completes 2-step addition problems. *
	Data Collections and Presentation	Interprets a graph. 3* Completes tables. 1 Tallies and interprets votes. 1 Completes a chart. 1 Conducts and interprets a survey. 1
	Estimation	Estimates an amount. 1 Estimates costs. 1 Interprets data and creates a graph. *

Units	Skill	Topic. Number of activities in which it is used
	Problem Solving	Arranges nonfiction books on a shelf. 1 Evaluates how to win a game. 1 Learns how to "split the difference" to compromise on the cost. 1 Analyzes data. 2 Chooses correct numbers to complete a story problem. 1 Solves 3-step problem. 2* Evaluates a buying decision. 1 Compares prices at three stores to determine the best buy. 1 Determines if children have enough money to buy an item. 1 Determines how long it takes to save a certain amount of money. 1 Uses different techniques to practice making change. 1 Uses logic to determine appropriate number answers. 1 Discovers math errors in a story. *
Level E (Grade 4)		
Unit 1: Home Health Detective Unit 2: State Visitors Center Unit 3: News Desk Unit 4: Desert Survival	Arithmetic Skills	Adds whole numbers and fractions. 2 Performs simple addition problems. 1 Performs simple subtraction problems. 2 Computes addition and multiplication problems. 1 Adds fractions with like denominators. 1 Sequences 2-digit numbers. 1 Subtracts two 2-digit numbers with re-grouping of tens to ones. 1 Subtracts two 2-digit numbers with re-grouping with 0 in the tens place. 1 Subtracts two 2-digit numbers with no regrouping. 1 Counts by ones. 1 Identifies and orders numbers - greater than, less than. 1 Adds and multiplies money amounts. 1 Solves two-step problems involving multiplication of money amounts. 1 Determines combinations of numbers that total to an equal or greater amount than a given amount. 1 Compares amounts. 2 Finds averages. 1 Determine and compares averages. 1 Solves two-step multiplication problems involving money amounts (less than one dollar) and single-digit numbers. 1 Estimates amounts. 1 Uses a calculator. 2
	Measurements	Makes comparisons by size. 2

Units	Skill	Topic. Number of activities in which it is used
	Data Analysis	Constructs, reads, and interprets numerical data using tables, charts, graphs, and maps. 13 Locates a specific building on a map. 1 Determines locations on a grid, using information from a table. 1 Analyzes information presented in a tree diagram in order to make inferences and generalizations. 1 Understands how to use symbols and fills in information on a tree diagram. 1 Interprets numbers within Bar Graph Data. 1 Evaluates information on a line graph. 1 Reads and interprets a pictograph. 3 Understands the function of keys on a graph. 2 Estimates locations on a bar graph. 1 Constructs pictographs. 1 Analyzes and compares data from chart. 1 Uses graphic sources for information about size. 4 Reads and compares information in a chart. 3 Reads and interprets charts - one, two and three digit numbers. 1 Interprets the key on a pictograph - numbers rounded to the nearest hundred thousand. 1 Understands the meaning of the symbols on the map. 1 Determines the grid locations for a given site. 2 Orders information from graphic sources. 1 Constructs, reads and interprets line graphs. 1 Interprets the key on a pictograph - numbers rounded to the nearest hundred thousand. 1 Fills in tables with numerical information. 1 Orders 4-digit numbers on a time line. 1
	Math Applications / Mathematical Processes	Classifies by common elements. 1 Determines right or left directionality. 1
Level F (Grade 5)		
Unit 1: School Proposals Unit 2: Food Bank Unit 3: Designing a Museum Unit 4: Climbing Mt. McKinley	Arithmetic Skills	Computes with whole numbers, fractions, decimals, integers and rational numbers - addition of 2-digit numbers - addition of columns. 10 Rounds numbers. 1 Computes percents. 1 Selects and uses an appropriate method for computing from among mental arithmetic, paper and pencil, calculator and computer. 1 Problem-solves - chooses appropriate operation. 1 Applies use of calculator. 1 Uses place value - numbers to hundred thousands. 1 Uses estimation to solve problems. 1

Units	Skill	Topic. Number of activities in which it is used
	Data Analysis	Constructs, reads and interprets tables, charts, graphs, schedules and maps. 21 Describes and represents relationships with bar graphs and understands statistics and probability. 1 Uses bar graphs to compare library resources. 1 Makes and compares line graphs and scatter plots. 1 Interprets financial information from cost sheet. 1 Solves problems using a schedule. 1 Locates street addresses on maps. 1 Explores problems and describes results using graphical models and representations. 4 Develops an appreciation for statistical methods as powerful means for decision-making. 2 Makes inferences and convincing arguments that are based on data analysis. 4 Systematically collects, organizes and describes data. 3
	Math Applications / Mathematical Processes	Uses computation, estimation and proportions to solve problems. 2 Sees mathematics as an integrated whole. 5 Values the role of mathematics in our culture and society. 3 Develops an appreciation for statistical methods as powerful means for decision-making. 5 Develops an appreciation for the wide use of probability in the real world. 4 Appreciates the wide use and power of reasoning as a part of mathematics. 2 Uses the skills of reading, listening and viewing to interpret and evaluate mathematical ideas. 3 Applies mathematical thinking and modeling to solve problems that arise in other disciplines. 5 Uses problem solving approaches to investigate and understand mathematical content. 5 Develops formulas, procedures for determining measures to solve problems. 2 Solves word problems involving money. 1 Extends understanding of the concepts of perimeter and area. 1 Makes predictions that are based on experimental or theoretical probabilities. 4 Recognizes and applies deductive and inductive reasoning. 2 Develops and applies a variety of strategies to solve problems, with emphasis on multi-step. 2 Understands, represents and uses numbers in a variety of equivalent forms (integers, fractions, decimals, percents) in a real world and mathematical problem situation. 1 Understands and applies ratios, proportions, and percents in a wide variety of situations. 1 Develops, analyzes and explains procedures for computation and techniques for estimation. 1 Uses patterns and functions to represent and solve problems. 1 Problem-solving: explores relationships among representations of numbering systems: Roman Numerals. 1 Makes inferences and convincing arguments that are based on data analysis. 1 Applies mathematical thinking and modeling to solve problems that arise in other disciplines. 8

Units	Skill	Topic. Number of activities in which it is used
	Quantitative Relationships	Calculates percents using survey data. 1 Computes proportions. 1 Determines ratio and proportions. 1
	Measurements	Calculates quantities in cubic feet. 1 Calculates areas in cubic feet, meters, kilometers. 2 Measures and calculates wind speed. 1 Explores perimeter and area. 1
Level G (Grade 6)		
Unit 1: Volunteering Unit 2: Yellowstone Connections Unit 3: Make TV Work for You	Arithmetic Skills	Computes using multiplication, division, estimation, decimals. 3 Uses computation, estimation and proportions to solve problems. 8 Multiplies and divides whole numbers. 2 Computes decimals. 2 Rounds decimal quotients. 1 Develops estimates. 1 Develops percents. 3 Describes problems involving the multiplication and division of decimals and fractions. 3 Develops number sense for whole numbers, fractions, decimals, place value/numbers to hundred trillion. 3 Calculates using estimates and percents. 3
Unit 4: Olympic Games	Measurements	Extends understanding of the concepts of perimeter, area. 1 Calculates area. 2 Interprets lengths within metric system. 2 Finds circumference of circle, using radius, diameter. 1 Converts feet to inches. 1 Calculates distance and speed. 1 Rounds to the nearest whole. 1 Explores units of time. 1 Selects appropriate units and tools to measure to the degree of accuracy required in a particular situation. 1
	Quantitative Relationships	Computes proportions. 2 Investigates relationships among fractions, decimals and percents. 1
	Data Analysis	Constructs, reads and interprets tables, charts and graphs. 10 Develops number sense - builds a timeline - compares and orders. 1 Solves problems by computing numbers - uses timeline. 1 Develops and calculates scheduling data using circle graph. 1 Interprets financial information from cost sheet. 1 Compares numerical data. 1 Makes inferences and convincing arguments that are based on data analysis. 4 Develops an appreciation for statistical methods as a powerful means for decision-making. 1

Units	Skill	Topic. Number of activities in which it is used
	Math Applications / Mathematical Processes	Uses problem solving approaches to investigate and understand mathematical concepts. 2 Develops and applies a variety of strategies to solve problems, with emphasis on multi-step problems. 2 Develops formulas, procedures for determining measures to solve problems. 2 Problem-solves using a scale model. 2 Values the role of mathematics in our culture and society. 12 Develops an appreciation for statistical methods as a powerful means for decision-making. 1 Sees mathematics as an integrated whole. 3 Recognizes and applies deductive and inductive reasoning. 4 Understands and applies ratios, proportions and percents in a wide variety of situations. 2 Makes inferences and convincing arguments that are based on data analysis. 3 Understands and applies reasoning processes, with special attention to reasoning with proportions and graphs. 3 Understands, represents and uses numbers in a variety of equivalent forms (fractions, decimals, percents) in real world and mathematical problem situations. 5
Level H (Grade 7)		
Unit 1: All Kinds of Families Unit 2: Medical Mix-Up Unit 3: Consumer Guide Unit 4: Maya Mystery	Arithmetic Skills	Computes whole numbers - addition, subtraction, multiplication, division, estimation. 6 Computes whole numbers - addition, subtraction. 2 Computes whole numbers - multiplication, division. 1 Computes whole numbers and decimals —addition, division, averaging. 1 Computes with whole numbers - fractions, decimals, addition, subtraction, multiplication, division. 5 Adds and averages decimals. 1 Multiplies and divides decimals and adds and subtracts integers. 4 Computes with decimals and percentages. 1 Relates multiplication situations involving combinations, and relates division situations involving rate to number sentences. 1 Interprets decimals and fractions. 1 Represents and interprets place value - numbers to millions. 4 Names two points on a number line that are equidistant from zero. 3 Uses computation, estimation and proportion to solve problems. 3 Uses problem solving approaches to investigate and understand mathematical content. 3 Develops an appreciation for the wide use of probability in the real world. 1

Units	Skill	Topic. Number of activities in which it is used
	Math Applications / Mathematical Processes	Develops number sense - compares and orders. 1 Interprets ancient number data. 3 Develops an appreciation for statistical methods as powerful means for decision-making. 11 Determines the best buy. 1 Understands, represents and uses numbers in a variety of equivalent forms (fraction, decimal, percent) in a real world and mathematical problem situation. 1 Sees mathematics as an integrated whole. 1 Extends understanding of the concepts of perimeter and spatial relationships. 1 Values the role of mathematics in our culture and society. 6 Explores relationships among representations of numbering systems. 3 Recognizes and applies deductive and inductive reasoning. 5 Uses the skills of reading and viewing to interpret and evaluate mathematical ideas. 3 Identifies information used in arriving at a particular conclusion. 1 Identifies trends in quantities graphed. 1 Understands and applies reasoning processes, with special attention to reasoning with proportions and graphs. 5 Formulates reasonable questions from given information. 4 Uses problem solving approaches to investigate and understand mathematical content. 2 Recognizes proportion and spatial relationships. 4 Makes inferences and convincing arguments that are based on data analysis. 4 Develops and applies a variety of strategies to solve problems, with emphasis on multi-step. 3 Applies mathematical thinking and modeling to solve problems that arise in other disciplines. 2 Makes predictions that are based on experimental or theoretical probabilities. 1 Acquires confidence in using mathematics meaningfully. 2
Level I (Grade 8)		
Unit 1: Earning Money Unit 2: Trouble in Camelot Unit 3: Making a Video Unit 4: Space Center	Arithmetic Skills	Computes money using whole numbers, fractions, decimals. 10 Uses computation, estimation and proportions to solve problems. 6 Applies use of calculator. 1
	Quantitative Relationships	Calculates ratios. 1 Understands and applies ratios, proportions and percents in a wide variety of situations. 2
	Measurements	Estimates, makes and uses measurements to describe & compare phenomena. 3 Calculates distance data. 1
	Data Analysis	Interprets money data. 1 Interprets money and percentages using tables. 2 Constructs, reads and interprets tables, charts and graphs. 10 Describes and represents relationships with tables, charts, graphs. 4 Systematically collect, organizes and describes data. 5 Computes and interprets numbers from timeline. 1

Units	Skill	Topic. Number of activities in which it is used
	Math Applications / Mathematical Processes	Acquires confidence in using mathematics meaningfully. 19 Develops and applies a variety of strategies to solve problems, with emphasis on multi-step problems. 17 Uses problem solving approaches to investigate and understand mathematical content. 2 Values the role of mathematics in our culture and society. 24 Makes predictions that are based on experimental or theoretical probabilities. 6 Estimates, makes and uses measurements to describe & compare phenomena. 7 Uses computation, estimation and proportions to solve problems. 5 Sees mathematics as an integrated whole. 3 Uses the skills of reading, listening and viewing to interpret and evaluate mathematical ideas. 3 Recognizes and applies deductive and inductive reasoning. 7 Applies mathematical thinking and modeling to solve problems that arise in other disciplines. 5 Understands, represents and uses numbers in a variety of equivalent forms in real world and mathematical problem situations. 3 Develops an appreciation for statistical methods as powerful means for decision-making. 10 Makes inferences and convincing arguments that are based on data analysis. 4 Develops an appreciation for the wide use of probability in the real world. 3 Uses the skills of reading, listening and viewing to interpret and evaluate mathematical ideas. 3 Appreciates the wide use and power of reasoning as a part of mathematics. 2 Understands and applies reasoning processes, with special attention to spatial reasoning and reasoning with proportions and graphs. 1 Develops and applies number theory concepts in real world and mathematical problem situations. 1 Appreciates the value of mathematical notation and its role in the development of mathematical ideas. 1

* Included in Student Activity Book

Part
6

Teaching with PLATO Early Mathematics

The PLATO Early Mathematics curricula are designed to be an on-line resource from kindergarten through the middle-school level. It is useful for teaching age-appropriate mathematics skills and concepts at the elementary level. In this section, we ll discuss some of the key questions conceming use of PLATO Early Mathematics as part of a larger mathematics curriculum. For further discussion of instructional models and strategies for integrating PLATO into your curricula, see *Technical Paper #6*

How much math teaching should I do online?

Because of the nature of early mathematics learning, we strongly recommend that your curriculum begin with teacher-led and other off-line math instruction activities. This is especially so for early elementary learners. The PLATO online instruction should be a resource that follows the introduction of skills and topics in class. *Projects for the Real World* has workbooks and worksheets keyed to specific modules, which you or the learners can print out and use to bridge to off-line activities. So, at each skill level, we expect this sequence of practice will work best:

Individualized Placement → Teacher-lead and other Off-line Instruction → PLATO Online Tutorials and Practice → PLATO Off-line Worksheets and Teacher-provided activities

This extended off-line practice is especially important because of the need to build *automaticity*—the ability to perform tasks with minimal cognitive load (without thinking about it). This frees up cognitive resources so that learners can focus on meeting higher-level challenges. Research has shown that building automaticity takes extensive practice. Thus, any well-balanced math program should include considerable practice with corrective feedback at appropriate levels of challenge.

I only have 4-8 computers in my classroom, and there is no lab. How can I use PLATO Early Mathematics?

You can organize your class into activity groups which rotate among on- and off-line activities. For example, a group of learners might work for one period online, then in the next period move to a PLATO printed worksheet, then in the next period move to a math assignment or project you have given them. You can use the management functions of the computer to assign lessons to learners, print computer reports to track learner progress, and make prescriptions for individual learners. You ll also want to make your computers available outside of class hours, so learners who need to work more slowly can do so.

What should my role be as learners use the PLATO courseware?

When introducing learners to the programs you may want to explain how the program is organized and demonstrate an activity. As learners spend their first days on the programs you will probably want to circulate among them and ask questions to assure that they are using the programs effectively. After they become comfortable with the program you may become more of a guide on the side. Let the learners work with PLATO software, using a combination of solo work and peer tutoring. Watch to see that they are using the skills being taught, and ask them open-ended questions designed to direct their attention to the relevant skills. Individualize assignments, using the PLATO reports to identify daily those learners who are having problems or who are not engaged. Focus on learners who are progressing slowly, or those whose time on task is abnormally low. Each day, intervene proactively with the learners who are having these problems. In activities with written assignments, have learners print out their work and turn them in daily so you can review the way they are using the math skill.

Can I use PLATO Early Math with my ESL/LEP learners?

The PLATO early math curricula aren t designed specifically as a complete solution for ESL/LEP use, but we have included many features which will make the courseware useful for these learners as part of their ESL/LEP curriculum. For example, audio, with replay, is available in most activities. In levels A-D, a recorder allows learners to record their own voice, or the teacher can record words and phrases in any language for the learners to play back. Many unusual terms are defined in PLATO courses.

Can I use PLATO Early Math with my LD learners?

The PLATO early math curricula aren t designed specifically as a complete solution for learning disabilities, but many of the principles of instructional design used in PLATO software are based on the same learning theory as recognized teaching techniques for the learning disabled. Consequently, LD teachers will find the self-paced structure, small steps with immediate feedback, and extensive practice to be particularly useful with LD learners. However, the lively multimedia design of PLATO software may not be appropriate for all LD learners, so be sure to review lessons before including them in individual learning plans (ILP s).

Do I have to use the PLATO modules in their published order?

Mathematics as a content/skill area is generally sequential in structure. The *Math Expeditions* course assumes that learners using the later levels, units, and lessons have prerequisite skills comparable to those taught in earlier sections. *Projects for the Real World* is less sequential in nature and a teacher may select a subset of lessons and activities to meet the needs of the class and the learners. You can select only the modules you want to use, and rearrange them to correspond to your textbook and other resources. As you do this you should be careful not to violate prerequisites due to the sequential nature of math content. As with all PLATO curricula, we strongly recommend that you carefully select all learning activities relevant to your state and local curriculum standards. Many such alignments are available from PLATO Learning, and training is available to show you how to build your own and incorporate additional off-line activities.

About the Authors

David W.(Bill) Quinn is currently working as an independent evaluator specializing in evaluating technology use for learning and teaching. He is particularly interested in supporting beginning literacy instruction with technology. He received a doctorate in educational evaluation from Western Michigan University in 1978 and a Masters in Instructional Science from Brigham Young University in 1975. Dr. Quinn had conducted numerous evaluation studies for clients in K-12, university, not-for-profit social services, and for-profit training companies. For ten years at the North Central Regional Educational Laboratory he was a Senior Program Associate where he managed the evaluation unit and evaluated technology use for the states of Indiana and Virginia, and for school districts in Chicago, Miami-Dade, and Los Angeles County. In the area of curriculum development and instructional design, Dr. Quinn directed a beginning reading curriculum development project at NCREL. He also oversaw the design and development of an Internet resource of research-based strategies for raising learner achievement in K-12 schools. He is the author of articles, reports, and book chapters on evaluating technology use in education, beginning reading instruction, and development of successful educational programs.

Wellesley R. (Rob) Foshay is the chief instructional architect of the PLATO system. He contributes to the instructional design knowledge base, standards and training for all product lines, and coordinates PLATO Learning s independent evaluation program. He consults often with clients and is a frequent spokesman for PLATO Learning at professional conferences and in print.

Prior to joining PLATO Learning, Inc., Dr. Foshay was for 8 years the Director of Product Quality Assurance, Standards and Training of Applied Learning International, Inc. (ALI) and its predecessor companies. Before joining ALI, Dr. Foshay served for 4 years on the faculty of the University of Illinois - Champaign. He began his career as a high school teacher and district media coordinator.

Dr. Foshay has published over 50 major journal articles, book chapters, and PLATO *Technical Papers*. He serves as a consulting editor to three research journals. Dr. Foshay has served on the Board of the International Society for Performance Improvement (ISPI). He was a founding member of the International Board of Standards for Training, Performance and Instruction (IBSTPI). He served on the ASQ/ANSI working group which developed ISO 9000 guidelines for quality management of education and training. Dr. Foshay has received awards from Indiana University, ISPI, and the Association for Educational Communications and Technology.

Dr. Foshay s training includes a Ph.D. in Instructional Development from Indiana University, a M.A. in Social Studies Education from Columbia University Teachers College, and a B.A. in Political Science from Oberlin College.

Barbara Morris is the President of Wasatch Interactive Learning, now a PLATO Learning company. She contributed to the instructional design and development of the *Math Expeditions* product. She incorporated her mathematics classroom teaching experience in elementary schools, middle schools and high schools and her twenty years experience in the effective use of technology to improve and enhance learning in the design of the *Math Expeditions* lessons.

Prior to joining PLATO Learning, Inc., Barbara Morris was CEO and Chairman of Wasatch Interactive Learning. Before Wasatch Interactive Learning, Ms. Morris served as Chairman and CEO of Wasatch Education Systems from 1992 to 1997. From 1988 to 1991, she was President of Tapestry Learning Corporation, a subsidiary of Jostens Learning Corporation and Group Vice President of Sales for Jostens Learning. From 1980 to 1988, Ms. Morris served increasingly responsible positions with Prescription Learning Corporation, initially as an educational consultant and finally as Vice President of Sales and Marketing and General Manager. Prior to joining Prescription Learning, she was a classroom teacher of mathematics for more than ten years.

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